## REMARKS

### Introduction

Claims 25-147 are pending in this application. Claims 25-143 were considered by the Examiner in the Final Office Action. Claims 144-147 were subsequently added by applicants in a Second Supplemental Amendment And Notification Pursuant To 37 C.F.R. § 1.604(b) Identifying A Published Patent Application From Which Claims Have Been Copied, filed on April 9, 2003.

Applicants have amended claims 26, 44, 45, 76, 87, and 92 to more particularly define the invention. Applicants respectfully submit that the amendments are fully supported and add no new matter.

Reconsideration of this application in light of the following remarks is hereby respectfully requested.

### Summary of the Examiner's Action

Claims 25, 27-43, and 95-143 were withdrawn from consideration as being directed to a non-elected invention.

The Request To Correct Inventorship, filed April 22, 2002, has been approved, and Rudy Mazzocchi has been added as an inventor.

Claims 46-52, 65-75, and 78-79 were objected to for having the same scope.

Claims 26 and 44-94 were rejected under 35 U.S.C. § 112 as being indefinite.

Claims 26, 44-58, and 63-94 were rejected under 35 U.S.C. § 102(b) as being anticipated by Marin et al. U.S. Patent No. 5,397,555 (hereinafter "Marin").

Claims 59-62 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Marin in view of Frantzen et al. U.S. Patent No. 5,843,164 (hereinafter "Frantzen").

The Examiner requested that applicants provide a list of all copending applications that set forth similar subject matter to the present claims. The Examiner further requested that a copy of such copending claims be provided in the response to this Office Action.

Applicants' Reply to the Objection to Claims 46-52, 65-75, and 78-79

The Examiner objected to claims 46-52, 65-75, and 78-79 as having the same scope. Specifically, the Examiner contended that each of claims 46-52 has the same scope, each of claims 65-68 has the same scope, each of claims 69-72 has the same scope, each of claims 73-75 has the same scope, and each of claims 78-79 has the same scope. Applicants concede that each of four of the groups of claims (i.e., claims 46-

52, 65-68, 69-72, and 73-75), contain claims that are identical. However, applicants respectfully submit that claims 78 and 79 are not identical and do not have the same scope.

Claims 46-52 and 65-75 were copied from an application of another. They were added in a Supplemental Amendment And Notification Pursuant To 37 C.F.R. § 1.604(b) Identifying Published Patent Applications From Which Claims Have Been Copied ("Notification"), filed February 26, 2002. In that Notification, applicants noted that language was being omitted from the claims that did not refer to patentably distinct features. These omissions resulted in the presentation of the groups of identical claims identified by the Examiner. Applicants acknowledge the requirement to cancel all but one of the duplicate claims from each of the groups of identical claims if they are allowed. However, applicants respectfully resubmit that all of the copied claims are fully supported by the original specification and drawings of this application.

Regarding claims 78 and 79, applicants respectfully submit that the claims do not have the same scope. Claim 78 refers to a connector wherein "spikes engage the same blood vessel" (emphasis added) and claim 79 refers to a connector

wherein "spikes engage different blood vessels" (emphasis added). Accordingly, these claims do not have the same scope. Applicants respectfully request that the objection to claims 78 and 79 be withdrawn.

Applicants' Reply to the Rejection of
Claims 26 and 44-94 under 35 U.S.C § 112

The Examiner rejected claims 26 and 44-94 under 35 U.S.C. § 112 as being indefinite because "the claim(s) include(s) elements not actually disclosed." The Examiner's rejections are respectfully traversed.

The Examiner asserts that the use of the phrase "cylinder-like" in the claims, renders the claims indefinite. Applicants respectfully submit that the phrase "cylinder-like" has clear meaning from the specification and is not indefinite.

Applicants' anastomotic connector is described in the specification as "an annular collar structure or ring 520b disposed concentrically around balloon 512b" (page 22, lines 9-11). Additionally, FIG. 17 shows a "cylinder-like" connector. Therefore, the meaning of "cylinder-like" would be clear to one of ordinary skill in the art, and the scope of the claims is readily ascertainable.

Accordingly, applicants' claims 26 and 44-94 are not indefinite. Applicants acknowledge the Examiner's

interpretation of "cylinder-like" as "cylinder," though they find it unnecessary, and respectfully request that the rejection of claims 26 and 44-94 be withdrawn.

Applicants' Reply to the Rejection of Claims 26, 44-58, and 63-94 under 35 U.S.C. § 102(b)

The Examiner rejected claims 26, 44-58, and 63-94 under 35 U.S.C. § 102(b) as being anticipated by Marin. Specifically, the Examiner contended that barbs 18 and ribs 14 meet the claim language. The Examiner's rejections are respectfully traversed.

Applicants have amended independent claims 26, 44, 45, 76, 87, and 92 to more clearly define the invention. Applicants' invention as defined by independent claims 26, 44, 45, 76, 87, and 92 is directed toward a connector used to form a fluid-tight anastomotic connection between two blood vessels via the sidewall of one of the blood vessels. According to applicants' preferred embodiment, anastomotic connectors are used to secure a tubular bypass graft between a blood source, such as the aorta, and an occluded coronary artery. In this example, the anastomotic connectors create fluid tight connections between the blood source and the graft and between the graft and the coronary artery.

Marin shows an intraluminal stent used to anchor an endolumnial graft coaxially within a diseased blood vessel. As stated by the Examiner, Marin shows barbs 18 that twist about ribs 14 to engage tissue. However, applicants respectfully submit that Marin does not show each and every feature of applicants' independent claims 26, 44, 45, 76, 87, and 92. Specifically, Marin fails to show the ability to form a fluid-tight anastomotic connection between a blood vessel and an opening in the sidewall of another blood vessel. *Anastomosis* is defined as "the union of parts or branches (as of streams, blood vessels, or leaf veins) so as to intercommunicate." Merriam-Webster's Collegiate Dictionary 42 (10th ed. 2001). Applicants illustrate an exemplary fluid-tight anastomotic connection in FIG. 34, in which conduit 430 is anastomosed to aorta 30 with struts 1436 via aorta wall 34. The stent shown in Marin has barbs that are designed to "engage the graft and the surface of the blood vessel to mechanically attach the stent to the vessel" (column 1, lines 60-62), but the stent is not capable of forming a fluid-tight anastomotic connection between a blood vessel and an opening in the sidewall of another blood vessel as claimed by applicants. A stent is a "short narrow metal or plastic tube that is inserted into the lumen of an

anatomical vessel (as an artery or a bile duct) especially to keep a formerly blocked passageway open" Merriam-Webster's Collegiate Dictionary 1148 (10th ed. 2001) (emphasis added). Marin merely shows a stent that might be used to coaxially install a graft in a diseased blood vessel. Marin neither shows nor suggests, expressly or inherently, using an anastomotic connector to make a fluid-tight connection between a blood vessel and an opening in the sidewall of another blood vessel. It is not clear how Marin's stent could create a fluid tight seal as claimed by applicants.

Because Marin fails to show, expressly or inherently, each and every feature of applicants claimed invention as defined by independent claims 26, 44, 45, 76, 87, and 92, the rejection of independent claims 26, 44, 45, 76, 87, and 92 should be withdrawn. Furthermore, since claims 46-58, 63-75, 77-86, 88-91, and 93-94 depend from independent claims 26, 44, 45, 76, 87, and 92, the rejection of claims 46-58, 63-75, 77-86, 88-91, and 93-94 should also be withdrawn. Therefore, applicants respectfully request that the rejection of claims 26, 44-58, and 63-94 be withdrawn.

Applicants' Reply to the Rejection of Claims 59-62 under 35 U.S.C. § 103(a)

The Examiner rejected claims 59-62 under 35 U.S.C. 103(a) as being unpatentable over Marin in view of Frantzen. Specifically the Examiner contended that Marin meets the language of claims 59-62, except for the super-elastic temperature-triggered shape-memory material which is shown in Frantzen. Because claims 59-62 depend from allowable independent claims 44 and/or 45, claims 59-62 are allowable. Independent claims 44 and 45 were not included in the Examiner's 35 U.S.C. § 103(a) rejection. Therefore, applicants respectfully request that the rejection of claims 59-62 be withdrawn.

The Examiner's Request Regarding Copending Applications

The Examiner requested that applicants provide a list of all copending applications that set forth similar subject matter to the present claims. The Examiner further requested that a copy of such copending claims be provided in response to this Office Action.

In response to the Examiner's requests, applicants are providing the following table that lists the copending applications that could arguably be said to set forth similar subject matter to the present claims. A copy of the claims

for each of these copending applications is provided in Appendix B. Because applicants are not sure what the Examiner means by "similar subject matter," applicants have tried to include in this submission everything of an even remotely related nature.

| Attorney Docket No. | Application No. | Filing Date |
|---|---|---|
| 293/002 Cont. 2 | 10/090,121 | 2/28/02 |
| 293/007 Cont. 2 | 10/090,113 | 3/1/02 |
| 293/008 Cont. 2 | 09/798,367 | 3/2/01 |
| 293/008 Cont. 3 | 09/798,514 | 3/2/01 |
| 293/008 Cont. 4 | 10/188,699 | 7/2/02 |
| 293/018 Cont. 2 | 10/171,425 | 6/12/02 |
| 293/034 Cont. | 09/569,607 | 5/10/00 |
| 293/034 Cont. 2 | 10/091,143 | 3/5/02 |
| 293/035 Div. | 10/120,299 | 4/9/02 |
| 293/036 Div. | 10/205,288 | 7/23/02 |
| 293/036 Cont. | 10/260,371 | 9/26/02 |
| 293/037 Cont. | 09/665,440 | 9/19/00 |
| 293/037 Div. 2 | 09/663,955 | 9/19/00 |
| 293/037 Cont. 2 | 09/695,639 | 10/24/00 |
| 293/038 Cont. | 10/345,470 | 1/15/03 |
| 293/040 Div. 2 | 10/309,387 | 12/2/02 |
| 293/044 | 09/587,112 | 6/2/00 |
| 293/044 Cont. | 10/078,940 | 2/19/02 |
| 293/045 | 09/693,578 | 10/20/00 |
| 293/045 CIP | 10/084,010 | 2/27/02 |
| 293/047 | 09/860,847 | 5/18/01 |
| 293/049 | 10/147,208 | 5/14/02 |
| 293/050 | 10/158,436 | 5/28/02 |

Applicants would like to point out to the Examiner that several of these patent applications include claims known to define the same patentable invention claimed in pending applications of another (i.e., of assignee BY-PASS, INC. of 40 Ramland Road, Orangeburg, NY 10962).

More specifically, the following copending applications:

293/002 Cont. 2
293/007 Cont. 2
293/018 Cont. 2
293/034 Cont. 2
293/036 Div.
293/044 Cont.

variously include claims from the following PCT publications of BY-PASS, INC.:

WO 99/62408
WO 99/62415
WO 00/56223
WO 00/56226
WO 00/56227
WO 00/56228
WO 01/41623
WO 01/41624
WO 01/70090
WO 01/70091
WO 01/70118
WO 01/70119
WO 02/30172

The exact correlation of how the claim numbers from the copending applications relate to the claim numbers in the BY-PASS, INC. PCT publications is set forth in Notifications that were submitted in each of the copending applications.

The copending applications* and the BY-PASS, INC. PCT publications are being cited under Group A in a Fifth

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* Applicants are citing only one application per family of applications because applications from the same family are substantially cumulative, unless a family includes a continuation-in-part.

Supplemental Information Disclosure Statement that is being submitted herewith. In addition, commonly-assigned U.S. patents that could arguably be said to set forth similar subject matter to the present claims are being cited under Group B in the Fifth Supplemental Information Disclosure Statement.

Conclusion

For at least the foregoing reasons, applicants respectfully submit that claims 26, 44-94, and 144-147 are allowable. Therefore, this application is in condition for allowance.

Accordingly, prompt reconsideration and allowance of this application are respectfully requested.

Respectfully submitted,

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Appendix A
Showing How the Claims Have Been Amended

26. (Amended) An anastomotic connector, comprising:

a cylinder-like body; and

at least one set of spikes, coupled to said body by twisting joints, wherein said set of spikes are bent and oriented to form a fluid-tight connection between a blood vessel and an opening in a sidewall of another blood vessel.

44. (Amended) An anastomotic connector for attaching two blood vessels, comprising:

a cylinder-like portion defining a lumen; and

a plurality of tissue engaging portions for engaging two blood vessels to form a fluid-tight connection between an opening in a sidewall of one of said two blood vessels and the other of said two blood vessels, said plurality comprising at least one spike, wherein radial expansion of said cylinder-like portion causes said at least one spike to engage tissue.

45. (Amended) An anastomotic connector for attaching two blood vessels, comprising:

a cylinder-like portion defining a lumen; and

a plurality of tissue engaging portions for engaging two blood vessels to form a fluid-tight connection

between an opening in a sidewall of one of said two blood vessels and the other of said two blood vessels, wherein radial expansion of said cylinder-like portion is coupled to axial contraction of said cylinder-like portion.

76. (Amended) An anastomotic connector for attaching two blood vessels, comprising:

a cylinder-like portion defining a lumen; and

a plurality of tissue engaging portions for engaging the blood vessels to form a fluid-tight connection between an opening in a sidewall of one of said two blood vessels and the other of said two blood vessels, said plurality comprising, at least two spikes, wherein said two spikes extend differently to engage said tissue.

87. (Amended) An anastomotic connector for attaching two blood vessels, comprising:

a cylinder-like portion defining a lumen; and

a plurality of tissue engaging portions for engaging the two blood vessels to form a fluid-tight connection between an opening in a sidewall of one of said two blood vessels and the other of said two blood vessels, wherein said connector has at least two configurations, a first configuration in which said tissue engaging portions are at a first extension state and a second configuration

wherein said tissue engaging portions are at a second extension state, wherein said connector exhibits a bi-modal behavior in changing from said first configuration to said second configuration.

92. (Amended) An anastomotic connector for attaching two blood vessels, comprising:

a cylinder-like portion defining a lumen; and

a plurality of tissue engaging portions for engaging the two blood vessels to form a fluid-tight connection between an opening in a sidewall of one of said two blood vessels and the other of said two blood vessels, wherein said connector has at least two configurations, a first configuration in which said tissue engaging portions form a vessel piercing tip and a second configuration wherein said tissue engaging portions are operative to engage tissue.

APPENDIX B
COPY OF THE CLAIMS FOR COPENDING APPLICATIONS THAT COULD ARGUABLY BE SAID TO SET FORTH SIMILAR SUBJECT MATTER TO THE PRESENT CLAIMS

Docket No.: 293/002 Cont. 2
Application No.: 10/090,121
Filing Date: 2/28/02

Pending Claims

1. A guided punch, comprising:

a sharp, extendible guide wire; and

a hollow punch mechanism adapted to ride on the guide wire, wherein said guide wire is adapted to extend from said punch.

2. A punch according to claim 1, wherein said punch is a rotating punch.

3. A punch according to claim 1, wherein said punch is an axially moving punch.

4. An anastomotic connector, comprising:

a cylinder-like body; and

at least one set of spikes, coupled to said body by twisting joints.

5. A connector according to claim 4, wherein said twisting joints comprise at least one torsion bar.

6. A connector according to claim 4, wherein said twisting joints comprise at least one bend area.

7. A medical graft delivery system, comprising:

a tubular element for delivering a graft through a bore thereof and having a delivery end, said end being prone to distortion; and

at least one collar removably encircling said delivery end, which collar prevents said distortion.

8. A system according to claim 7, wherein said tube comprises weakened portions at or adjacent said delivery end.

9. A system according to claim 7, comprising an anastomotic connector preloaded in said delivery end and applying outward forces against said end.

10. A system according to any of claims 7-9, wherein said at least one collar comprises at least two collars.

11. A method of sealing an opening between two blood conduit lips, comprising:

providing a clip;

first retracting a first lip into said clip; and

second retracting a second lip into said clip.

12. A method according to claim 11, comprising closing said clip to seal said opening.

13. A method according to claim 12, wherein closing comprises releasing said clip to selfdeform.

14. A method according to claim 12, wherein closing comprises plastically deforming said clip.

15. A method according to any of claims 11-14, wherein said two lips are lips of different conduits.

16. A method according to any of claims 11-14, wherein at least one of the conduits comprises a blood vessel.

17. A reducing profile anastomotic connector, comprising:

a ring section;

a spikes section comprises a plurality of spikes, wherein said spikes section defines a collapsing portion, for axial collapsing of said spikes section.

18. A connector according to claim 17, wherein said collapsing portion buckles.

19. A connector according to claim 17, wherein said collapsing portion twists.

20. A connector according to claim 17, wherein said collapsing portion folds out.

21. A connector according to any of claims 17-20, wherein said collapsing portion selfdeforms.

22. A connector according to any of claims 17-20, wherein said collapsing portion plastically deforms.

23. A delivery system for an anastomosis connector, comprising:

a body including a handle for applying force;

a connector holder area defined at a distal end of said body and adapted for holding an anastomosis connector, wherein said force is transferred to said area for deploying said connector; and

a non-limp geometry changing elongate section bridging between said body and said area.

24. A system according to claim 23, wherein said elongate section is distortable.

25. A delivery system for an anastomosis connector, comprising:

a body including a handle for applying force;

a connector holder area defined at a distal end of said body and adapted for holding an anastomosis connector, wherein said force is transferred to said area for deploying said connector; and

a control for selectively advancing a plurality of tissue engaging elements from said connector holder area, said control being separate from said handle for applying force.

26. A system according to claim 25, wherein said control is mounted on a separate capsule element that includes said connector holder area.

27. A system according to claim 25, wherein said tissue engaging elements form part of a connector.

28. A system according to claim 25, wherein said tissue engaging elements form part of said delivery system.

Pending Claims

1. A vascular attachment device for sealing an opening between two blood conduit lips, comprising:

at least one clip element adapted for sealing at least a portion of an opening between two blood conduit lips; and

at least one puller adapted for pulling, inside the body, at least one of said lips into said clip element.

2. A device according to claim 1, wherein said puller is attached to said device.

3. A device according to claim 1, wherein said puller is adapted to remain in a body after use.

4. A device according to claim 1, wherein said puller is adapted to penetrate said lip.

5. A device according to claim 1, wherein said puller is adapted to transfix said lip.

6. A device according to claim 1, wherein said at least one clip comprises a plurality of clips cooperating to seal said opening.

7. A device according to claim 6, wherein said plurality of clips are not connected to each other.

8. A device according to claim 6, wherein said plurality of clips are interconnected.

9. A device according to claim 8, wherein said plurality of clips are flexibly interconnected.

10. A device according to claim 1, wherein said clip distorts to effect said seal.

11. A device according to claim 10, wherein said clip comprises two arms that bend towards each other to effect said seal.

12. A device according to claim 10, wherein said clip distorts plastically.

13. A device according to claim 12, comprising a delivery system comprising a contra
element and a pressure element, which two elements compress said clip between them.

14. A device according to claim 10, wherein said clip self-distorts.

15. A device according to claim 14, comprising a delivery system comprising a restraining
element adapted to selectively release said clip, to self distort.

16. A device according to claim 1, wherein said clip comprises barbs, for engaging said lips.

17. A device according to claim 1, wherein said clip comprises protrusions, for engaging said lips.

18. A device according to claim 1, wherein said clip is adapted to seal said lips against each other.

19. A device according to claim 1, wherein said clip is adapted to seal said lips against a part of said clip.

20. A device according to claim 1, wherein said clip compresses said lips, to effect said seal.

21. A device according to any of claims 1-20, wherein said lips are lips of two different conduits.

22. A device according to any of claims 1-20, wherein at least one of said conduits is an invivo blood vessel.

23. A device according to any of claims 1-20, wherein at least one of said conduits is a synthetic graft.

24. A guided punch, comprising:

a sharp, extendible guide wire; and

a hollow punch mechanism adapted to ride on the guide wire, wherein said guide wire is adapted to extend from said punch, wherein said punch is adapted for injection of contrast material inside of said hollow of said punch mechanism.

25. A delivery system for an anastomosis connector, comprising:

a body including a handle for applying force;

a connector holder area defined at a distal end of said body and adapted for holding an anastomosis connector, wherein said force is transferred to said area for deploying said connector;

a non-limp geometry changing elongate section bridging between said body and said area; and

a flexible cable for transferring said force between said handle and said area.

Pending Claims

1. A connector for use in making an artificial, fluid-tight connection between an end portion of a tubular graft conduit and a side wall of a tubular body conduit in a patient via an artificially formed aperture in the side wall of the tubular body conduit so that the tubular graft conduit extends from the tubular body conduit outside of the tubular body conduit and the patient's body fluid can flow between lumens of the tubular graft conduit and the tubular body conduit via the connection, the connector comprising:

a structure that is annularly continuous but annularly enlargeable and configured for disposition substantially concentric with the tubular graft conduit, the structure including:

(a) a plurality of cantilevered, longitudinal, tissue-piercing members disposed in an annular array that is substantially concentric with the annularly continuous structure, a cantilevered length of each of the tissue-piercing members being great enough to allow the tissue-piercing member, in use, to pass all the way through the side wall of the tubular graft conduit and to become partly extraluminal of the tubular graft conduit, the tissue-piercing members having strength sufficient to secure the tubular graft conduit to the connector when thus passed through the side wall of the tubular graft conduit; and

(b) a plurality of retention fingers disposed in an annular array that is substantially concentric with the annularly continuous structure, the retention fingers being extendable, in use, radially outwardly relative to the artificially formed aperture and inside the tubular body conduit, the retention fingers having length sufficient when thus extended radially outwardly to engage the inside of the

side wall of the tubular body conduit at locations annularly around the artificially formed aperture, and the retention fingers having strength sufficient when thus engaged with the inside of the side wall of the tubular body conduit to at least help retain the tubular graft conduit in fluid-tight, artificial connection with the tubular body conduit.

2. The connector defined in claim 1 wherein the structure further comprises:

a ring having convolutions that repeatedly traverse a circumference of the structure.

3. The connector defined in claim 1 wherein the retention fingers are resiliently biased to extend substantially radially outwardly to engage the inside of the side wall of the tubular body conduit, and wherein the retention fingers are additionally configured to elastically deflect substantially parallel to an axis about which the structure is annular.

4. The connector defined in claim 1 wherein the structure is at least partly made of nitinol.

5. The connector defined in claim 1 wherein the structure is at least partly made of stainless steel.

6. The connector defined in claim 2 wherein the ring is produced from a tube by removing interdigitated portions from the tube, alternating removed portions extending in from opposite ends of the tube.

7. Apparatus for use with a connector as defined in claim 1 comprising:

a tubular structure axially reciprocable relative to the connector into and out of a position in which

the tubular structure is substantially concentric outside the connector and releasably holds the retention fingers substantially parallel to an axis about which the structure is annular.

8. The connector defined in claim 1 wherein the retention fingers initially extend substantially parallel to an axis about which the structure is annular and are configured for plastic deformation to extend substantially radially outwardly to engage the inside of the side wall of the tubular body conduit.

Pending Claims

1. A connector for use in connecting a tubular body tissue graft to the side wall of a patient's tubular body tissue conduit so that the lumen of the graft communicates with the lumen of the conduit through an aperture in the side wall of the conduit to permit body fluid flow between the lumens without leakage of body fluid to the outside of the graft and the conduit adjacent the connector comprising:

an annular structure having first and second axially adjacent substructures, the first substructure being configured to be disposed inside the conduit, wherein the first substructure comprises a plurality of annularly spaced struts that are configured to extend from a first position in which the struts are substantially parallel to an axis with which the annular structure is substantially coaxial to a second position in which the struts are substantially radially outward to engage the inside of the side wall of the conduit at locations that are disposed annularly around the aperture, and the second substructure being configured to engage the inside of the graft at further locations that are also disposed annularly around the aperture.

2. The connector defined in claim 1 wherein the second substructure is configured to penetrate the tissue of the graft adjacent the further locations.

3. The connector defined in claim 1 wherein the first and second substructures are configured to resiliently press the graft and the conduit into annular contact with one another annularly around the aperture.

4. The connector defined in claim 1 wherein the structure further comprises:

an annular ring.

6. The connector defined in claim 1 wherein the second substructure comprises a plurality of annularly spaced prongs.

7. The connector defined in claim 6 wherein each prong has a free end that is configured to penetrate the tissue of the graft.

8. The connector defined in claim 7 wherein the free end of each prong is sharply pointed to facilitate penetration of the tissue of the graft by the prong.

9. The connector defined in claim 1 wherein the structure further comprises an annular ring, and wherein the first and second substructures are attached to the ring at respective locations that are spaced from one another along the ring parallel to an axis about which the ring is annular.

10. The connector defined in claim 9 wherein the plurality of struts are spaced annularly around the ring.

11. The connector defined in claim 10 wherein the struts are resiliently biased to extend radially out from the ring.

12. The connector defined in claim 11 wherein the struts are configured to elastically deflect substantially parallel to an axis with which the annular structure is substantially coaxial.

13. Apparatus for use with a connector as defined in claim 12 comprising:

a tubular structure axially reciprocable relative to the connector into and out of a position in which the tubular structure is substantially concentric outside the annular structure and releasably holds the struts substantially parallel to the axis with which the annular structure is substantially coaxial in the first position.

14. The connector defined in claim 9 wherein the second substructure comprises a plurality of prongs spaced annularly around the ring.

15. The connector defined in claim 14 wherein the prongs are configured to extend radially out from the ring.

16. The connector defined in claim 1 wherein the annular structure is at least partly made of nitinol.

17. The connector defined in claim 1 wherein the annular structure is at least partly made of stainless steel.

18. The connector defined in claim 1 wherein the annular structure is produced from a tube by removing portions from the tube.

Pending Claims

1. A connector for use in connecting an axial end portion of a tubular medical graft to the side wall of a patient's tubular body tissue conduit so that the lumen of the graft communicates with the lumen of the conduit through an aperture in the side wall of the conduit to permit body fluid flow between the lumens without leakage of body fluid to the outside of the graft and the conduit adjacent the connector comprising:

an annular structure having first and second axially adjacent substructures, the first substructure being configured to be disposed substantially concentrically inside the axial end portion of the graft and being circumferentially enlargeable to press the axial end portion of the graft radially outwardly toward the body tissue surrounding the aperture, and the second substructure including a plurality of struts that are configured to extend substantially radially outwardly to engage the body tissue surrounding the aperture and hold the axial end portion of the graft in body-fluid-tight engagement with the side wall of the conduit annularly around the aperture, the side wall having a wall thickness, wherein the first substructure is resiliently biased to circumferentially enlarge to at least some degree by itself, and wherein the struts extend substantially radially outwardly from the graft a radial distance of at least the wall thickness of the side wall when engaged with the body tissue surrounding the aperture.

2. The connector defined in claim 1 wherein the first substructure further comprises:

a ring having convolutions that repeatedly traverse a circumference of the annular structure, the ring being

circumferentially enlargeable by straightening out the convolutions to some degree.

3. The connector defined in claim 1 wherein the struts are configured to extend through the annular portion of the graft to engage surrounding body tissue.

4. The connector defined in claim 1 wherein the struts include hooks configured to penetrate surrounding body tissue.

5. The connector defined in claim 1 wherein the struts include barbs configured to penetrate surrounding body tissue and to resist withdrawal of the struts from the penetrated body tissue.

6. The connector defined in claim 1 wherein the struts are resiliently biased to extend substantially radially outwardly to engage surrounding body tissue, and wherein the struts are additionally configured to elastically deflect substantially parallel to an axis with which the annular structure is substantially coaxial.

7. The connector defined in claim 1 wherein the struts are resiliently biased to extend substantially radially outwardly to engage surrounding body tissue, and wherein the struts are additionally configured to elastically deflect substantially into a cone which has its apex on an axis about which the annular structure is substantially coaxial.

8. The connector defined in claim 1 wherein the annular structure is at least partly made of nitinol.

9. The connector defined in claim 1 wherein the annular structure is at least partly made of stainless steel.

10. The connector defined in claim 2 wherein the ring is produced from a tube by removing interdigitated portions from the tube, alternating removed portions extending in from opposite ends of the tube.

11. The connector defined in claim 10 wherein the tube has thickness less than the spacing between adjacent removed portions.

12. The connector defined in claim 1 wherein the annular structure further comprises:

a tissue clamping structure configured to move toward the struts in response to circumferential enlargement of the annular structure in order to clamp tissue between the clamping structure and the struts.

13. The connector defined in claim 12 wherein the annular structure further comprises:

a ring which is serpentine along a circumference of the annular structure, the struts being connected to the ring adjacent one axial end of the connector and the tissue clamping structure being attached to the ring adjacent the other axial end of the connector so that when the ring is circumferentially enlarged and the ring accordingly becomes less serpentine, the struts and the tissue clamping structure move toward one another.

14. The connector defined in claim 13 wherein the tissue clamping structure comprises:

a second ring substantially parallel to and concentric with the first-mentioned ring.

15. The connector defined in claim 14 wherein the tissue clamping structure comprises a plurality of struts connecting the second ring to the first-mentioned ring

adjacent said other axial end of the connector.

16. The connector defined in claim 6 further comprising:

a tubular structure axially reciprocable relative to the connector into and out of a position in which the tubular structure is substantially concentric outside the annular structure and releasably holds the struts substantially parallel to the axis with which the annular structure is substantially coaxial.

17. The connector defined in claim 7 further comprising:

a yieldable structure for releasably holding the struts in the cone.

18. The connector defined in claim 17 wherein the yieldable structure comprises:

a yieldable band around the struts.

19. The connector defined in claim 17 wherein the yieldable structure comprises:

a yieldable cone over the struts.

20. The connector defined in claim 7 further comprising:

a removable member around the struts.

21. The connector defined in claim 20 wherein the removable member comprises:

a wire wrapped around the struts.

22. The connector defined in claim 20 wherein the removable member comprises:

a coil around the struts configured to release the

struts when the coil is rotated about its central longitudinal axis.

23. The connector defined in claim 7 wherein each of the struts includes an initially radially inwardly directed hook, and wherein the connector further comprises:

a removable member for releasably engaging the hooks.

24. The connector defined in claim 1 wherein the annular structure further comprises:

a multi-sided ring having a plurality of radially outwardly pointing corners circumferentially spaced from one another around the ring.

25. A connector for use in connecting an axial end portion of a tubular medical graft to the side wall of a patient's tubular body tissue conduit so that the lumen of the graft communicates with the lumen of the conduit through an aperture in the side wall of the conduit to permit body fluid flow between the lumens without leakage of body fluid to the outside of the graft and the conduit adjacent the connector comprising:

an annular structure having first and second axially adjacent substructures, the first substructure being configured to be disposed substantially concentrically inside the axial end portion of the graft and being circumferentially enlargeable to press the axial end portion of the graft radially outwardly toward the body tissue surrounding the aperture, and the second substructure including a plurality of struts that are configured to extend from a first position in which the struts are substantially longitudinal to an axis about which the annular structure is substantially coaxial to a second position in which the struts are substantially radially outward to engage the body tissue surrounding the

aperture and hold the axial end portion of the graft in body-fluid-tight engagement with the side wall of the conduit annularly around the aperture, wherein the first substructure is resiliently biased to circumferentially enlarge to at least some degree by itself.

26. The connector defined in claim 25 wherein the first substructure further comprises:

a ring having convolutions that repeatedly traverse a circumference of the annular structure, the ring being circumferentially enlargeable by straightening out the convolutions to some degree.

27. The connector defined in claim 25 wherein the struts are configured to extend through the annular portion of the graft to engage surrounding body tissue.

28. The connector defined in claim 25 wherein the struts include hooks configured to penetrate surrounding body tissue.

29. The connector defined in claim 25 wherein the struts include barbs configured to penetrate surrounding body tissue and to resist withdrawal of the struts from the penetrated body tissue.

30. The connector defined in claim 25 wherein the struts are resiliently biased to extend from the first position to the second position.

31. The connector defined in claim 25 wherein the struts are resiliently biased to extend from the first position to the second position, and wherein the struts form a cone which has its apex on an axis about which the annular structure is substantially coaxial when in the first position.

32. The connector defined in claim 25 wherein the annular structure is at least partly made of nitinol.

33. The connector defined in claim 25 wherein the annular structure is at least partly made of stainless steel.

34. The connector defined in claim 26 wherein the ring is produced from a tube by removing interdigitated portions from the tube, alternating removed portions extending in from opposite ends of the tube.

35. The connector defined in claim 34 wherein the tube has thickness less than the spacing between adjacent removed portions.

36. The connector defined in claim 25 wherein the annular structure further comprises:

a tissue clamping structure configured to move toward the struts in response to circumferential enlargement of the annular structure in order to clamp tissue between the clamping structure and the struts.

37. The connector defined in claim 36 wherein the annular structure further comprises:

a ring which is serpentine along a circumference of the annular structure, the struts being connected to the ring adjacent one axial end of the connector and the tissue clamping structure being attached to the ring adjacent the other axial end of the connector so that when the ring is circumferentially enlarged and the ring accordingly becomes less serpentine, the struts and the tissue clamping structure move toward one another.

38. The connector defined in claim 37 wherein the tissue clamping structure comprises:

a second ring substantially parallel to and concentric with the first-mentioned ring.

39. The connector defined in claim 38 wherein the tissue clamping structure comprises a plurality of struts connecting the second ring to the first-mentioned ring adjacent said other axial end of the connector.

40. The connector defined in claim 30 further comprising:

a tubular structure axially reciprocable relative to the connector into and out of a position in which the tubular structure is substantially concentric outside the annular structure and releasably holds the struts substantially parallel to the axis with which the annular structure is substantially coaxial.

41. The connector defined in claim 31 further comprising:

a yieldable structure for releasably holding the struts in the cone.

42. The connector defined in claim 41 wherein the yieldable structure comprises:

a yieldable band around the struts.

43. The connector defined in claim 41 wherein the yieldable structure comprises:

a yieldable cone over the struts.

44. The connector defined in claim 31 further comprising:

a removable member around the struts.

45. The connector defined in claim 44 wherein the

removable member comprises:

a wire wrapped around the struts.

46. The connector defined in claim 44 wherein the removable member comprises:

a coil around the struts configured to release the struts when the coil is rotated about its central longitudinal axis.

47. The connector defined in claim 31 wherein each of the struts includes an initially radially inwardly directed hook, and wherein the connector further comprises:

a removable member for releasably engaging the hooks.

48. The connector defined in claim 25 wherein the annular structure further comprises:

a multi-sided ring having a plurality of radially outwardly pointing corners circumferentially spaced from one another around the ring.

Pending Claims

1. A method of forming spike tips of an anastomotic connector, into hooks for engaging blood vessels, comprising:

providing an anastomosis connector having a plurality of straight spikes having tips;

first bending said tips at a first angle, using a first mandrel; and

second bending a furtherly distal portion of said tips using a second mandrel, to form a hook shape of said tips.

2. A method according to claim 1, comprising mounting a graft on said spikes of said connector prior to said first bending.

3. A method of heat-treating an anastomosis connector, comprising:

fitting a cut connector into a mold;

fixing said mold to bend both forward and backwards spikes of said connector into a desired configuration; and

heat-treating said fixed connector, thereby training it to said configuration.

4. A connector adapter to be distorted for oblique connections, comprising:

a plurality of interconnected segments, at least some of said segments including a forward spike or a backward spike; and

a plurality of distortable portions defined between said segments, wherein said portions are adapted to support a distortion from a straight anastomosis to an oblique

anastomosis.

5. A connector according to claim 4, wherein said distortable portions comprise at least one ring.

6. A connector according to claim 4, wherein said distortable portions are designated in a ring that interconnects said segments.

7. A connector according to claim 4, wherein said distortable portions are annealed.

8. A connector according to claim 4, wherein said spikes are self extending.

9. A connector according to claim 4, wherein said distortable portions are plastically deformable.

10. An anastomotic connector comprising:

a plurality of clip segments each defining a clip contact area at which opposite sides of the clip engage tissue; and

a plurality of attachment segments that interconnect the clip segments, wherein said attachment segments lie in a first circumference and said contact areas lie in a second circumference and wherein said two circumferences are not the same.

11. A connector according to claim 10, wherein a resilience of said attachment segments is defined to control a diameter changing behavior of said connector.

12. A connector according to claim 10, wherein said circumferences are not on a same plane.

Pending Claims

1. A connector for use in making an artificial, fluid-tight, hollow, annular connection between an end portion of a tubular graft conduit and a side wall of a tubular body conduit in a patient via an artificially created aperture in the side wall of the tubular body conduit so that the tubular graft conduit extends from the tubular body conduit outside of the tubular body conduit and the patient's body fluid can flow between lumens of the tubular graft conduit and the tubular body conduit via the connection, the connector comprising:

a structure which is annularly continuous and configured for disposition annularly within the inside of the tubular graft conduit;

a plurality of first members extending from the structure in an annular array which is substantially concentric with the structure, the first members being resiliently biased to extend substantially radially out from the structure and being elastically deflectable substantially parallel to a central longitudinal axis of the structure; and

a plurality of second members extending from the structure in an annular array which is substantially concentric with the structure, the second members being resiliently biased to extend substantially radially out from the structure and being elastically deflectable substantially parallel to the central longitudinal axis of the structure, the first members being configured to pass through the side wall of the tubular graft conduit at respective locations that are spaced from one another around the side wall of the tubular graft conduit, and the first and second members being further configured to reach respective locations on the side wall of the tubular body conduit that are spaced annularly around the aperture when the connector is in use and the first

and second members are extending substantially radially out from the structure.

2. The connector defined in claim 1 wherein the first and second members extend from respective first and second axially spaced portions of the structure.

3. The connector defined in claim 1 wherein when the first and second members are deflected substantially parallel to the central longitudinal axis of the structure, they extend in respective opposite directions away from the structure.

4. The connector defined in claim 1 comprising nitinol.

5. The connector defined in claim 1 wherein the first and second members are further configured for disposition on respective opposite sides of the side wall of the tubular body conduit when the connector is in use and the first and second members are extending substantially radially out from the structure.

6. The connector defined in claim 1 wherein the structure is perforated.

7. The connector defined in claim 1 wherein the structure is configured for annular flexibility.

8. The connector defined in claim 1 wherein the structure is configured for axial flexibility.

9. The connector defined in claim 1 wherein the structure and the first and second members are all one piece.

Pending Claims

1. A method of sealing an opening between two blood conduit lips, comprising:

providing a clip;

first retracting a first lip into said clip;

second retracting a second lip into said clip; and

providing a pharmaceutical at said seal.

2. A method according to claim 1, wherein said pharmaceutical comprises a clot enhancing pharmaceutical.

3. A method according to claim 1, wherein providing comprises providing a layer of material comprising said pharmaceutical.

4. A method according to claim 3, wherein said layer is provided between said lips

5. An anastomotic connector for attaching two blood vessels, comprising:

a cylinder-like portion defining a lumen, having two ends and comprising an array of cells-elements; and

a tissue engaging portion comprising at least one set of spikes comprising at least one spike arranged adjacent one of the two ends of said cylinder-like portion.

6. A connector according to claim 5, comprising at least a second set of spikes adjacent the other of the two ends.

7. An anastomotic connector for attaching two blood vessels, comprising:

a cylinder-like portion defining a lumen; and

a plurality of tissue engaging portions for engaging two blood vessels, said plurality comprising at least one spike, wherein radial expansion of said cylinder-like portion causes said at least one spike to engage tissue, wherein said cylinder-like portion comprises a plurality of cell elements.

8. An anastomotic connector for attaching two blood vessels, comprising:

a cylinder-like portion defining a lumen; and

a plurality of tissue engaging portions for engaging two blood vessels, wherein radial expansion of said cylinder-like portion is coupled to axial contraction of said cylinder-like portion, wherein said cylinder-like portion comprises a plurality of cell elements.

9. A connector according to claim 6 or 7, wherein said at least one spike is arranged to extend out of said lumen when said tissue engaging portions engage tissue in a completed anastomosis.

10. A connector according to claim 9, wherein said extended spike lies in a plane perpendicular to said cylinder-like portion.

11. A connector according to claim 6 or 7, wherein said device is arranged to release said at least one spike to assume an extended configuration by an expansion of said cylinder-like portion.

12. A connector according to claim 6 or 7, wherein said spike comprises a protrusion to prevent engaged tissue from slipping off said spike.

13. A connector according to claim 6 or 7, wherein

said spike comprises a protrusion to prevent engaged tissue from slipping along said spike beyond said protrusion.

14. A connector according to claim 6 or 7, wherein said spike is arranged to bend at least 90° when it extends.

15. A connector according to claim 6 or 7, wherein said spike is arranged to bend at least 150° when it extends.

16. A connector according to claim 6 or 7, wherein said spike is arranged to bend at least 180° when it extends.

17. A connector according to claim 6 or 7, wherein said spike is arranged to bend at least 210° when it extends.

18. A connector according to claim 6 or 7, wherein said spike is arranged to bend at at least two points thereon when it extends.

19. A connector according to claim 6 or 7, wherein said spike is arranged to bend in a continuous curve when it extends.

20. A connector according to claim 6 or 7, wherein said at least one spike comprises at least two spikes and wherein said connector comprises at least a second spike and wherein said second spike is arranged to bend towards said at least one spike and said at least one spike is arranged to bend towards at least a second spike.

21. A connector according to claim 20, wherein spikes of said at least a second spike are arranged to be in a same plane as spikes of said at least one spike, when the spikes are in a bent configuration.

22. A device according to any of claims 5-8, wherein said lumen has an elliptical cross-section.

23. A device according to any of claims 5-8, wherein said lumen has a circular cross-section.

24. A device according to any of claims 5-8, wherein said lumen has a polygonal cross-section.

25. A device according to any of claims 5-8, wherein said lumen has a varying inner diameter, wherein said inner diameter has an hourglass profile, being flared at the ends of the lumen.

26. A device according to any of claims 5-8, wherein said lumen has a varying inner diameter, wherein said lumen is flared at one end of the lumen.

27. A device according to any of claims 5-8, wherein a cross-section of said lumen varies along said lumen.

28. A device according to any of claims 5-8, wherein said lumen is matched to a coronary vessel.

29. A device according to any of claims 5-8, wherein at least one of said cell elements has parallelogram geometry.

30. A device according to any of claims 5-8, wherein at least one of said cell elements is arranged to distort out of a plane of said cell, when that cell is expanded along a certain axis thereof.

31. A device according to any of claims 5-8, wherein at least one of said cell elements comprises an

outline geometrical shape.

32. A device according to any of claims 5-8, wherein at least one of said cell elements is not planar.

33. A device according to any of claims 5-8, wherein said cells are arranged as bands on at least a portion of said cylinder-like portion, each of said bands comprising substantially a single type of parallelogram.

34. A device according to claim 33, wherein said bands are axial bands.

35. A device according to claim 33, wherein said bands are circumferential bands.

36. A device according to any of claims 5-8, wherein substantially all of said cylinder-like portions is composed of cell-elements.

37. A device according to any of claims 5-8, wherein said cell elements meet at junctions and comprising at least one substantially rigid strut interconnecting at least two junctions.

38. A device according to any of claims 5-8, wherein said cell elements meet at junctions and comprising at least one substantially flexible wire interconnecting at least two junctions.

39. A device according to any of claims 5-8, wherein said cylinder-like portion comprises several cell types and wherein said cell types are uniformly distributed on said cylinder-like portion.

40. A device according to any of claims 5-8, wherein said cylinder-like portion comprises at least one part which comprises a temperature-triggered shape-memory material.

41. A device according to any of claims 5-8, wherein said at least one of tissue engagers comprises at least one part which comprises a temperature-triggered shape-memory material.

42. A device according to any of claims 5-8, wherein said anastomotic connector is adapted to engage a side of one of said vessels and an end of another of said vessels, to perform a side-to-end anastomosis.

43. A device according to claim 42, wherein said anastomosis is sealed by radial pressure exerted by said cylinder-like portion and wherein said tissue engagers maintain the cylinder-like portion in its position.

44. A device according to claim 42, wherein said tissue engagers maintain the relative positions of the two blood vessels.

45. A device according to claim 42, wherein said tissue-engaging portions are arranged on said cylinder-like portion such that when the anastomosis is complete, the cylinder like portion is at a certain angle perpendicular to the "side" vessel.

46. A device according to claim 42, wherein said certain angle is between about 70° and about 90°.

47. A device according to any of claims 5-8, wherein at least one of said tissue engagers is adapted to engage an everted graft.

48. A device according to any of claims 5-8, wherein at least one of said tissue engagers is adapted to both an everted and a non-everted graft.

49. A method of implanting a clip from inside a blood vessel, comprising:

providing a clip having at least two spikes inside the blood vessel;

spreading apart the spikes and maintaining them in said spread configuration;

retracting said clip such that said clip engages said blood vessel on either side of a hole in said vessel; and

releasing said clip.

50. A method according to claim 49, wherein releasing said clip comprises releasing at least one end of a thin cable that holds said clip in a loop of said cable.

51. A method according to claim 49, comprising releasing said spikes from said spread configuration after said retracting.

52. An anastomotic connector for connecting a graft to a target vessel, comprising:

a thin collar section, adapted to engage a portion of the graft; and

a separate spike section, adapted to mount on said collar section and comprising a plurality of spikes, each of said spikes adapted to transfix said graft.

53. A connector according to claim 52, wherein said spike section comprises a super-elastic material.

54. A connector according to claim 52, wherein said spikes are pre-bent in a hook shape, such that said hook shape

is adapted to engage the target vessel.

55. A connector according to claim 52, wherein said collar section defines a cylindrical volume.

56. A connector according to claim 52, wherein said collar section is adapted to form a perpendicular anastomosis.

57. A connector according to claim 52, wherein said collar section is adapted to form an oblique anastomosis.

58. A delivery system for an anastomotic connector comprising:

a body including a handle for applying force;

a connector holder area defined at a distal end of said body and adapted for holding an anastomosis connector, wherein said force is transferred to said area for deploying said connector; and

a non-limp geometry changing elongate section bridging between said body and said area, wherein said system is adapted for holding and deploying a two part connector comprising a plurality of tissue engaging elements that are retracted by said force during deployment, such that a base ring portion of the connector is engaged by the holder area and a tissue puller portion of the connector is retracted by said force.

Pending Claims

1. A method for installing a tubular graft between first and second spaced locations in a patient's tubular body structure comprising:

providing a first aperture through a wall of the tubular body structure at the first location with a distal portion of an elongated structure inserted into and along a lumen of the tubular body structure to the first location;

passing the graft along a lumen of the tubular body structure until a distal portion of the graft extends out of said first aperture;

providing a surgical access opening in the patient adjacent one of the first and second locations;

moving the distal portion of the graft assembly to the second location; and

attaching axially spaced portions of the graft to the tubular body structure adjacent the first and second locations.

2. The method defined in claim 1, wherein the step of moving the distal portion of the graft assembly comprises accessing the distal portion of the graft with instrumentation inserted into the surgical access opening.

3. The method defined in claim 1, wherein the step of attaching axially spaced portions of the graft to the tubular body structure comprises forming anastomotic connections between the graft and the tubular body structure so that the patient's body fluid can flow between the lumen of the tubular body structure and the interior of the graft.

4. The method defined in claim 3, wherein the step

of attaching axially spaced portions of the graft to the tubular body structure comprises forming an anastomotic connection between the end of the graft and one of the apertures in the wall of the tubular body structure.

5. The method defined in claim 1, further comprising:

providing a graft installing structure having a sharpened configuration adjacent a distal end portion of the graft,

wherein the step of moving the distal portion of the graft to the second location comprises using a distal portion of the graft installing structure to pierce the tubular body structure.

6. The method defined in claim 5, wherein the graft installing structure has a cutting structure, and the step of moving the distal portion of the graft to the second location comprises using the cutting structure of the graft installing structure to provide a second aperture in the tubular body structure.

7. The method defined in claim 6, wherein the graft installing structure has a dilating structure coaxially mounted with respect to the graft, and the step of moving the distal portion of the graft to the second location comprises enlarging the second aperture with the dilating structure by advancing the dilating structure through the wall of the tubular body conduit at the second location.

8. The method defined in claim 6, further comprising:

before the step of passing the graft assembly along a lumen of the tubular body structure, attaching a connector to an end portion of the graft.

9. The method defined in claim 8, wherein the step of attaching axially spaced portions of the graft to the tubular body structure comprises:

attaching one of the end portions of the graft to the tubular body structure with the connector.

10. The method defined in claim 9, wherein the graft installing structure has an expandable component adjacent the end portion of the graft and the connector and wherein the step of attaching axially spaced portions of the graft to the tubular body structure comprises:

expanding a component of the graft installing structure to radially expand a portion of the connector.

11. A method for installing a tubular graft having first and second end portions between first and second spaced locations in a patient's tubular body structure, and wherein at least one of the first and second end portions of the graft is anastomosed with a connector to one of the first and second locations, and wherein delivery of the graft to the first and second locations is at least facilitated by an intraluminal step and a surgical access step.

12. The method defined in claim 11, wherein the intraluminal step comprises:

passing an elongated structure inserted into and along a lumen of the body structure to the first location; and

providing an aperture in a wall of the body structure at the first location by cutting the wall of the body structure at the first location with a sharpened end of the elongated structure.

13. The method defined in claim 12, wherein the intraluminal step further comprises:

passing the graft through a lumen of the elongated

structure to bring the second end portion of the graft through the aperture.

14. The method defined in claim 11, wherein the surgical access step comprises:

providing a surgical acess opening in the patient adjacent one of the first and second locations.

15. The method defined in claim 14, wherein the surgical access step further comprises:

inserting the graft through the surgical access opening to bring the first and second end portions of the graft to the first and second locations using instrumentation inserted through the surgical access opening.

16. The method defined in claim 12, wherein the surgical access step comprises:

providing a surgical access opening in the patient adjacent one of the first and second locations;

inserting the graft through the surgical access opening using instrumentation inserted through the surgical access opening;

guiding the first end portion of the graft to the first location using the instrumentation; and

guiding the second end portion of the graft to the second location using the instrumentation.

17. The method defined in claim 16, wherein guiding the first end portion of the graft to the first location comprises guiding the first end portion into the aperture.

18. The method defined in claim 16, wherein guiding the second end portion of the graft to the second location comprises piercing a wall of the body structure at the second location with a sharpened end of the connector attached to the

second end portion.

19. The method defined in claim 12, wherein the intraluminal step further comprises:

passing an elongated guide structure into and along a lumen of the elongated structure through the aperture.

20. The method defined in claim 19, wherein the surgical access step comprises:

providing a surgical access opening in the patient adjacent one of the first and second locations;

removing an end of the elongated guide structure out of the patient through the surgical access opening using instrumentation inserted through the surgical access opening;

inserting the graft over the elongated guide structure through the surgical access opening to bring the first end portion of the graft to the first location using the instrumentation; and

guiding the second end portion of the graft to the second location using the instrumentation.

21. The method defined in claim 20, wherein bringing the first end portion of the graft to the first location comprises guiding the first end portion into the aperture.

22. The method defined in claim 20, wherein guiding the second end portion of the graft to the second location comprises piercing a wall of the body structure at the second location with a sharpened end of the connector attached to the second end portion.

23. The method defined in claim 13, wherein the surgical access step comprises:

providing a surgical access opening in the patient

adjacent one of the first and second locations; and

guiding the second end portion of the graft to the second location using instrumentation inserted through the surgical access opening.

24. The method defined in claim 23, wherein guiding the second end portion of the graft to the second location comprises piercing a wall of the body structure at the second location using a sharpened end of the connector attached to the second end portion.

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Pending Claims

1. A guided punch, comprising:

a sharp, extendible guide wire; and

a hollow punch mechanism adapted to ride on the guide wire, wherein said guide wire is adapted to extend from said punch, and wherein said punch comprises a hollow tube adapted to fit between said punch mechanism and said guide wire.

2. A rotating punch, comprising:

a sharp, central guide wire;

a rotating outer tube having a vascular cutting edge defined by a lip of said tube; and

a hollow tube adapted to be brought over said guide wire and within said rotating outer tube.

3. An anastomotic connector, comprising:

a cylinder-like body; and

at least one set of spikes, coupled to said body by twisting joints, wherein said spikes are adapted not to penetrate tissue which the spikes contact.

4. An anastomotic connector, comprising:

a cylinder-like body; and

at least one set of spikes, coupled to said body by twisting joints, wherein said set of spikes are bent at two different locations along the spikes.

5. A method of performing an anastomosis, comprising:

engaging at least one of the vessels of a two vessel anastomosis, using a plurality of retractable spikes; and

retracting said plurality of retractable spikes, to cause at least a partial eversion of said vessel.

6. A method according to claim 5, comprising, completing said anastomosis.

7. An anastomosis delivery system for delivering a connector having at least one backwards spike having a bent tip, comprising:

a hollow guide sheath;

a cylindrical capsule having one open end and one closed end; and

an anastomosis connector held in said capsule.

8. A system according to claim 7, comprising a stopper arranged between a plurality of said backwards spikes and urging said spikes towards said capsule.

9. An anastomotic connector, comprising:

a cylinder-like body; and

at least one set of spikes, coupled to said body by twisting joints, wherein each spike comprises two arms that meet at a tip of the spike and are each attached to a different part of said connector.

10. A vascular attachment device for sealing an opening between two blood conduit lips, comprising:

a ring element;

a plurality of fingers mounted on said ring element and adapted to seal at least a portion of an opening between two blood conduit lips by compressing said at least two lips between a finger and at least one of said finger and said ring; and

at least one puller spike adapted for pulling, inside the body, at least one of said lips to a space defined

between said finger and said ring.

11. A device according to claim 10, wherein said fingers are restrained back from a resting position in which they engage said lip in said space.

12. A device according to claim 10, wherein each puller has a sharp tip adapted for insertion through a graft wall.

13. A device according to claim 10, wherein said ring has the shape of an ellipse.

14. A device according to claim 10, wherein said fingers do not penetrate any of said lips.

15. A vascular attachment device for sealing an opening between two blood conduit lips, comprising a plurality of bendable clips, said clips being adapted for gripping two lips between them and for sealing said opening by forcing said lips towards each other, wherein said clip elements are blunt and do not penetrate said blood conduit walls.

16. A device according to claim 15, wherein said clips are arranged on a ring.

17. A connector delivery system for delivering a ring connector having a plurality of fingers, said fingers defining an open configuration and a closed configuration mounted thereon, comprising:

a retractor;

a tube integral with a plurality of puller spikes and coupled to said retractor for retraction thereby; and

an outer tube adapted to close a plurality of said fingers, when said puller spikes are retracted into said ring

connector.

18. A system according to claim 17, wherein said fingers close plastically.

19. A system according to claim 18, wherein said outer tube has an inner lip with an inner diameter smaller than an outer diameter of said connector, such that when said outer tube is moved relative to said connector, said fingers are pushed inwards by the inner lip towards said ring.

20. A system according to claim 17, wherein said fingers close to said closed configuration by said fingers being released.

21. A system according to claim 20, wherein said outer tube defines an inner lip, against which said fingers are held away from said ring, such that when said outer tube is retracted, said fingers are released from said lip and close.

22. A system according to claim 17, comprising a stationary tube for maintaining said connector in place relative to said integral tube.

23. A method of mounting a graft on a spiked connector, in which the tips of the spikes define a periphery, comprising:

placing the graft, in said periphery, between tips of said spikes and a piercable element;

impaling said piercable element on said spikes, such that the graft is also impaled on said spikes; and

removing said piercable element from said spikes.

24. A method according to claim 23, comprising,

pulling back impaled parts of said graft to a side of the spikes opposite said tips.

25. A method according to claim 23, wherein said impaling comprises advancing said spike tips towards said graft.

26. A method according to claim 23, comprising bending said spike tips into hooks after said impaling.

27. A method according to claim 23, comprising forming said spike tips into hooks before said impaling.

28. A method of mounting a graft on a spiked connector, comprising:

placing the graft between tips of said spikes and an element having a general outer perimeter;

advancing said spikes relative to said element such that said spikes penetrate said graft and penetrate said perimeter; and

removing said element.

29. A method according to claim 28, wherein said element is formed of a hard material and includes a plurality of depressions to receive said spikes.

30. A method according to claim 28, wherein said element is piercable by said spikes.

31. A method according to claim 28, wherein said element is non-expandable.

32. A method according to any of claims 28-31, wherein advancing said spikes comprises advancing spikes that are adapted for engaging a target vessel of the anastomosis.

33. A method of mounting a graft on a connector having a plurality of spikes arranged around a central opening, said spikes having radially outward pointing hooks, comprising:

folding said spikes such that said hooks point inward into said central opening and define a periphery between them;

inserting a graft into said periphery;

advancing said hooks relative to said graft, to penetrate said graft; and

repositioning said hooks to point outward.

34. A method according to claim 33, wherein advancing said hooks comprises moving said spikes.

35. A method according to claim 33, wherein advancing said hooks relative to said graft comprises radially expanding said graft towards said hooks.

36. A method according to claim 33, comprising, inserting a contra mandrel in said graft, to limit an advance of said hooks.

37. A method according to any of claims 33-36, wherein repositioning said hooks comprises unfolding said spikes.

38. A method of mounting a graft on a connector having a plurality of spikes arranged around a central opening, said spikes having radially outward pointing hooks, comprising:

inserting a graft into a periphery defined by forward ends of said spikes, in a first direction;

folding back a tip of said graft to cover said hooks; and

pulling back said graft, in a direction opposite said first direction, such that said hooks engage said folded part of said graft.

39. A method according to claim 38, comprising advancing said engaged part of said graft towards a base of said spikes, in said opposite direction.

40. An anastomotic connector, comprising:

a base ring;

a plurality of target spikes, adapted to engage a target vessel, which target spikes pass through said ring; and

a plurality of retractable pulling spikes, having tips adapted to engage a graft placed in the lumen of said ring, and being adapted to at least partially evert a lip of said graft when said pulling spikes are retracted.

41. A connector according to claim 40, wherein said target spikes are hooked.

42. A connector according to claim 40, wherein said target spikes are inclined towards an axis of said connector.

43. A connector according to claim 40, wherein said puller spikes are provided through said base ring.

44. A method of partially everting a graft on a connector, comprising:

inserting a graft into a ring shaped anastomosis connector having a plurality of spikes; and

pulling an end of said graft radially out, so that said end abuts said spikes adjacent the spikes and extends radially out of said spikes between said spikes.

45. A method according to claim 44, wherein said

pulling comprises pulling using retractable spikes.

46. A graft everting method, comprising:

mounting at least an end of said graft on an expandable tube;

expanding said tube to engage and expand said graft; and

rolling back at least a portion of said end over itself.

47. A method according to claim 46, comprising, providing a tube over said graft, so said rolling back is on to said tube.

48. A tool for compressing a tip of a graft, comprising:

an outer mandrel mounted over the graft and reaching to about an opening in the graft;

an inner mandrel mounted inside the graft and reaching to about said opening; and

a base, wherein said base and said two mandrel define a space for said graft to extend into when the mandrels are brought together.

49. A tool according to claim 48, wherein said inner mandrel is mounted on said base.

50. A tool according to claim 48, wherein said inner mandrel is adapted to engage at least a portion of said graft.

51. A tool according to claim 48, wherein said outer mandrel is adapted to engage at least a portion of said graft.

52. A tool for forming an oblique eversion for a graft, comprising:

a tube ; and

at least one axial extension of said tube, such that a spiked connector disposed in said tube can project at least one of its spikes near a base of said projection.

53. A tool according to claim 52, wherein said at least one projection comprises at least two projections defining a slot between them, with said spike extending through said slot.

54. A tool for forming an oblique eversion for a graft, comprising:

a tube adapted for having a graft and a connector mounted therein; and

an over-tube which radially restrains at least one spike of said connector, wherein said connector can be moved relative to said over-tube.

55. A tool according to claim 54, wherein said over tube is slotted and wherein said motion is rotation.

56. A tool according to claim 54, wherein said motion comprises axial motion of said connector relative to said over-tube.

57. A tool according to claim 56, wherein said tube is a same element as said over tube.

58. A vascular attachment device for sealing an opening between two blood conduit lips, comprising:

at least one clip element adapted for sealing at least a portion of an opening between two blood conduit lips; and

at least one puller adapted for pulling, inside the body, at least one of said lips into said clip element, wherein said puller is adapted to not penetrate said lip.

59. A vascular attachment device for sealing an opening between two blood conduit lips, comprising:

at least one clip element adapted for sealing at least a portion of an opening between two blood conduit lips; and

at least one puller adapted for pulling, inside the body, at least one of said lips into said clip element, wherein said puller is adapted to be distorted by said clip.

60. A vascular attachment device for sealing an opening between two blood conduit lips, comprising:

at least one clip element adapted for sealing at least a portion of an opening between two blood conduit lips; and

at least one puller adapted for pulling, inside the body, at least one of said lips into said clip element, wherein said clip comprises a slot, for engaging said lips.

61. A method of simulating eversion of a graft, comprising:

compressing an end of said graft into a form to provide a thickening of said end; and

transfixing said thickening with at least one spike of an anastomosis connector.

62. A method according to claim 61, wherein said graft comprises a mammary artery.

63. A method according to claim 61, wherein said transfixing comprises transfixing along an axis of said graft.

64. A method according to claim 61, wherein said form comprises an inner mandrel.

65. A method according to claim 61, wherein said form defines, on said graft, a flat end surface for said thickening.

66. A method according to claim 61, wherein said form defines, on said graft, an oblique end surface for said thickening.

67. A method according to claim 61, wherein said form defines, on said graft, a nonplanar end surface for said thickening.

68. A method of transfixing a connector on a graft, comprising:

widening a radius of an end of the graft;

advancing at least one spike of said connector, parallel to said graft, such that it transfixes said widened area; and

bending at least an end of said spike to form a hook.

69. An anastomosis connector, comprising:

a plurality of ring segments, together defining a radially expandable ring-like shape having a lumen;

at least one pivot bar coupled to at least one of said ring segments; and

at least one spike mounted on said pivot bar and rotatable around said pivot bar, wherein radial deformation of said ring-like shape does not substantially directly affect said spike rotational position.

70. A connector according to claim 69, wherein said

at least one spike is pointed towards said ring-like shape.

71. A connector according to claim 69, wherein said at least one spike is pointed away from said ring-like shape.

72. A connector according to claim 69, wherein said at least one spike comprises at least two spikes, each mounted on a separate pivot bar, wherein said spikes point in opposite directions along an axis of said connector.

73. A connector according to claim 69, wherein said connector is designed such that said at least one spike remains outside of a side vessel in an end-to-side anastomosis.

74. A connector according to claim 69, wherein said connector is designed such that said at least one spike enters a side vessel in an end-to-side anastomosis.

75. A connector according to claim 69, wherein said pivot bar is comprised in a spike element.

76. A connector according to claim 75, wherein said spike element is attached to only a single ring element.

77. A connector according to claim 69, wherein said at least one spike has a tip adapted to penetrate a blood vessel.

78. A connector according to claim 69, wherein said at least one spike has a tip adapted to lay against a blood vessel without penetrating it.

79. A connector according to claim 69, wherein said connector is heat-treated to have said at least one spike

perpendicular to said ring.

80. A connector according to claim 69, wherein said connector is heat-treated to have said at least one spike parallel to said ring.

81. A connector according to claim 69, wherein said connector is heat-treated to have said at least one spike bend.

82. A connector according to claim 69, wherein said connector is heat-treated such that said at least one spike does not bend.

83. A connector according to claim 69, wherein said pivot bar is within an axial extent of said ring-like shape.

84. A connector according to claim 83, wherein said pivot bar is substantially centered relative to said ring like shape.

85. A connector according to claim 69, wherein said pivot bar is outside an axial extent of said ring-like shape.

86. A connector according to claim 69, wherein said pivot bar is straight.

87. A connector according to claim 69, wherein said pivot bar is piece-wise straight.

88. A connector according to claim 69, wherein said at least one spike is cut out of an opposing spike of said connector.

89. A connector according to claim 69, wherein at

least one of said ring segments comprises a plurality of axially spaced elements.

90. A connector according to claim 89, wherein said plurality of elements comprises at least three elements.

91. A connector according to claim 89, wherein said plurality of elements comprises at least four elements.

92. A connector according to claim 89, wherein said plurality of elements comprises at least five elements.

93. A connector according to claim 89, wherein at least two of said plurality of elements have mirrored geometries.

94. A connector according to claim 89, wherein at least one of said plurality of elements has a single curve geometry.

95. A connector according to claim 89, wherein at least one of said plurality of elements has a dual curve geometry.

96. A connector according to claim 89, wherein at least one of said plurality of elements has at least three curves defined thereby.

97. A connector according to claim 89, wherein at least one of said plurality of elements has a varying width.

98. A connector according to claim 89, wherein all of said plurality of elements have a constant width.

99. An anastomosis connector comprising:

a ring shaped base having an axis;

at least one plurality of spikes on one side of said ring; and

at least one trans-axial thickening in at least one of said spikes, distanced from said ring.

100. A connector according to claim 99, comprising a second plurality of spikes pointing in an opposite direction from said first set of spikes.

101. A rotating punch, comprising:

a sharp, central guide wire; and

a rotating outer tube having a vascular cutting edge defined by a lip of said tube.

102. A punch according to claim 101, wherein said outer tube advances as it is rotated.

103. A punch according to claim 101, wherein said cutting edge is smooth.

104. A punch according to claim 101, wherein said cutting edge is serrated.

105. A punch according to claim 101, wherein said guide wire is smooth.

106. A punch according to claim 101, wherein said guide wire is adapted to engage vascular tissue it is inserted into.

107. A punch according to any of claims 101-106, wherein said outer tube is bent at a right angle, such that positioning perpendicular to a vessel wall is assisted.

108. A punch according to any of claims 101-106, comprising a balloon distal from said cutting edge, said balloon, when inflated, having an outer diameter slightly greater than a diameter of said outer tube and about the inner diameter of a sheath associated with said punch.

109. An advancing rotating punch, comprising:

a sharp, central guide wire; and

a rotating outer tube adapted to cut a target vessel which advances relative to said wire when it rotates.

110. A hole puncher, adapted for punching a hole in a blood vessel, comprising:

an outer tube having distal portion, which distal portion has a lip; and

a punch element having a sharp tip and defining a depression distal from the tip, wherein said depression is of a size adapted to receive a blood vessel, wherein said distal portion of said outer tube has an outer diameter which is substantially the same as an outer diameter of said punch element and wherein said punch element fits snugly in said distal portion such that said lip can sever blood vessel tissue contained in said depression from tissue outside said depression.

111. A hole puncher according to claim 110, wherein said depression is distanced from said tip so that said distance is at least the thickness of the blood vessel.

112. A puncher according to claim 110, wherein said puncher is flexible enough to be provided through a blood vessel in which a hole is to be punched.

113. A puncher according to claim 110, comprising a handle.

114. A puncher according to claim 113, comprising means for advancing said outer tube relative to said handle and relative to said punch element.

115. A puncher according to claim 113, comprising means for retracting said punch element relative to said handle and relative to said outer tube.

116. A puncher according to any of claims 110-115, comprising means for advancing a graft into said hole formed by said punch.

117. A puncher according to any of claims 110-115, wherein said distal end is radially expandable from a first, small diameter to a second, working diameter.

118. A method of punching a hole in a blood vessel, comprising:

providing a hole puncher to a location in a vascular system, which location has blood flowing therethrough;

transfixing a wall of said vascular system at said location;

removing a portion of said wall using said hole puncher, while said hole-puncher remains transfixing said wall; and

transporting a tool across said wall through a lumen of said hole puncher.

119. A method according to claim 118, wherein said removing comprises partially retracting a portion of said hole puncher.

120. A method according to claim 118, wherein said removing comprises partially advancing a portion of said hole puncher.

121. A method according to any of claims 118-120, wherein said providing is from inside of said vascular system.

122. A method according to any of claims 118-120, wherein said providing is from outside of said vascular system.

123. An anastomotic connector comprising:

a plurality of clip segments; and

a plurality of twistable resilient segments that interconnect the clip segments, wherein said clip segments do not penetrate target tissue when the clip closes.

124. An anastomotic connector comprising:

a plurality of connection segments each defining a contact area between the segment and a target blood vessel; and

a plurality of attachment segments that interconnect said connection segments and limit relative motion of the connection segments, wherein some of said attachment segments limit relative motion of said connection segments more than the motion of other connection segments is limited.

125. A connector according to claim 124, wherein said connection segments each comprises a clip element.

126. A delivery system for an anastomosis connector, comprising:

a body including a handle for applying force;

a capsule adapted to interlock with said body and for carrying a connector, wherein said force is transferred by said interlocking to deploy said connector; and

an extension, adapted to be selectively connected between said body and said capsule, thereby extending a reach of said delivery system.

127. A system according to claim 126, wherein said extension is bendable.

Pending Claims

1. Instrumentation for facilitating penetration of a side wall of a tubular body tissue conduit from the interior lumen of the conduit comprising:

a tubular structure which is axially insertable into and along the lumen of the conduit and which has an axial portion configured to deflect toward a first portion of the interior surface of the side wall from a second portion of the interior surface of the side wall which is axially spaced from the first portion and on the side of the side wall which is substantially opposite the first portion, the tubular structure having an axially extending interior passageway with an opening to the exterior of the tubular structure adjacent the first portion; and

a laterally flexible, longitudinal, tissue piercing structure configured to pierce a side wall of the tubular body tissue conduit and to project from the side wall through any adjacent tissue outside of the tubular body tissue conduit, wherein said tissue piercing structure is axially insertable into and along the passageway and which is axially reciprocable relative to the tubular structure so that it exits the opening toward the first portion when moved toward the opening.

2. The instrumentation defined in claim 1 wherein the tubular structure is configured to resiliently deflect toward the first portion.

3. The instrumentation defined in claim 2 wherein the passageway is configured to removably receive an alternative longitudinal structure which is laterally stiffer than the tissue piercing structure, and wherein the axial

portion is further configured to substantially conform to an alignment of the alternative longitudinal structure, rather than deflect, in response to presence of the alternative longitudinal structure in the passageway in the axial portion.

4. The instrumentation defined in claim 1 further comprising:

radiologic marking of the axial portion.

5. The instrumentation defined in claim 1 further comprising:

radiologic marking of the opening.

6. The instrumentation defined in claim 1 wherein the axial portion is an axially medial portion of the tubular structure which is configured to arch toward the first portion from the second portion and from a third portion of the interior surface of the side wall which is on the same side of the side wall as the second portion, the second and third portions being axially spaced from the first portion in respective opposite axial directions from the first portion.

7. The instrumentation defined in claim 6 wherein the opening is a lateral branch of the passageway which extends in both axial directions past the opening.

8. The instrumentation defined in claim 1 wherein the tissue piercing structure comprises a radiologic material.

9. A method of penetrating a side wall of a tubular body tissue conduit from the interior lumen of that conduit comprising:

inserting a first laterally flexible, but relatively stiff, longitudinal structure axially into and along the lumen;

inserting a second laterally flexible longitudinal structure axially into and along the lumen in engagement with the first structure so that the second structure substantially conforms to alignment of the first structure in the lumen, the second structure having an axial portion which, when not in engagement with the first structure, tends to deflect transversely in the lumen so that a part of the axial portion is adjacent to a first portion of the interior of the side wall of the conduit;

removing the second structure from engagement with the axial portion so that the axial portion can deflect; and

inserting a third laterally flexible, and relatively less stiff, longitudinal, tissue piercing structure axially into and along the lumen in engagement with the axial portion so that the third structure follows at least part of the axial portion and is thereby directed toward the first portion for piercing of the first portion of the interior of the side wall of the conduit to project from the side wall through any adjacent tissue outside of the tubular body tissue conduit by the third structure.

10. Apparatus for use in medical treatment of a patient's tubular body conduit comprising:

an elongated, laterally flexible but resilient structure having (1) an axially medial portion configured for axial insertion into and along a lumen of the body conduit and also for axial reciprocation through an aperture in a side wall of the body conduit, and (2) an axially distal portion configured for passage along the lumen of the body conduit in either axial direction along that lumen from the aperture.

11. The apparatus defined in claim 10 wherein the medial portion is sufficiently laterally flexible so that a distal part of that portion can extend inside the lumen in a first length of the conduit which extends axially in a first

direction from the aperture and so that a proximal part of that portion can extend axially along a path which is outside the first length of the conduit and which forms an acute angle with the first length of the conduit.

12. The apparatus defined in claim 11 wherein the medial portion is sufficiently resilient so that when the medial portion is pulled sufficiently far out of the lumen via the aperture that the distal portion remaining in the first length of the conduit is too short to be constrained by the first length of the conduit, the medial portion switches the distal portion into a second length of the conduit which extends axially in a second direction from the aperture.

13. The apparatus defined in claim 12 wherein the medial portion is additionally sufficiently laterally stiff to allow the medial portion to be used to push the distal portion axially along the lumen of the second length of the conduit from outside the conduit.

14. The apparatus defined in claim 10 wherein the distal portion forms an atraumatic distal end for the medial portion.

15. The apparatus defined in claim 10 wherein the medial portion comprises a metal wire.

16. The apparatus defined in claim 10 wherein the distal portion is radially enlarged relative to the medial portion.

17. The apparatus defined in claim 10 wherein the distal portion comprises radiologically viewable material.

18. Apparatus for inserting a tubular graft into a

side wall of a tubular body tissue conduit from outside the conduit comprising:

a hollow tubular shaft structure configured to receive a longitudinal guide structure axially along a lumen inside the shaft structure so that the shaft structure and the guide structure can slide axially relative to one another; and

a substantially conical tip structure disposed on an axial end portion of the shaft structure substantially concentrically with the shaft structure so that an apex of the conical tip structure points axially away from the shaft structure, an axial continuation of the lumen inside the shaft structure extending through the tip structure and out at the apex so that the guide structure can extend through the axial continuation and can slide axially relative to the axial continuation, the shaft structure being configured to receive the graft annularly around the shaft structure, and the tip structure including an annular recess which extends substantially annularly around the shaft structure, the recess being open in a direction that points away from the apex, and the recess having a radially outer side wall that is radially spaced from the shaft structure by an amount sufficient to allow an annular axial end portion of the graft to be received in the recess with the outer side wall radially outside the portion of the graft that is thus received in the recess.

19. The apparatus defined in claim 18 wherein the conical tip structure has a cone angle less than about 15°.

20. The apparatus defined in claim 18 wherein the conical tip structure has a cone angle in the range from about 5° to about 15°.

21. The apparatus defined in claim 18 wherein the conical tip structure has a cone angle in the range from about 5° to about 10°.

22. The apparatus defined in claim 18 wherein the tip structure is configured for passage through the side wall from outside the conduit starting with the apex of the tip structure.

23. The apparatus defined in claim 18 wherein the recess is configured to additionally receive at least an axial end portion of an annular graft connector which is annularly attached to an axial end portion of the graft.

24. The apparatus defined in claim 18 further comprising:

a radially expandable structure disposed substantially annularly around the shaft structure inside a graft around the shaft structure.

25. The apparatus defined in claim 24 wherein the expandable structure comprises:

an annular balloon.

Pending Claims

1. A connector for use in connecting an end of a tubular graft conduit to a side wall of a patient's existing tubular body conduit via an aperture in the side wall thereof, comprising:

a first plurality of fingers configured to engage an interior surface of the side wall of the existing conduit;

a second plurality of fingers configured to engage an exterior surface of the side wall of the existing conduit,

wherein the pluralities of fingers are substantially radially aligned with respect to a longitudinal axis and the connector is radially deformable between a first size and a second size.

2. The connector defined in claim 1, wherein the connector is an integral unit.

3. The connector defined in claim 1, further comprising:

a third plurality of fingers configured to pierce the graft conduit.

4. The connector defined in claim 3, wherein one of the third plurality of fingers has a barbed end portion.

5. The connector defined in claim 3, wherein one of the third plurality of fingers has a narrow neck portion between a pair of shoulder portions for retaining a portion of the graft conduit between said shoulder portions.

6. The connector defined in claim 1, wherein one of the first plurality of fingers is provided with a sharpened

end portion for piercing the graft conduit.

7. The connector defined in claim 1, wherein a pair consisting of adjacent ones of the first and second pluralities of fingers defines a substantially "U"-shaped configuration when viewed from a plane extending radially out the longitudinal axis of the connector.

8. The connector defined in claim 1, wherein the pluralities of fingers are resilient.

9. The connector defined in claim 1, wherein the first and second pluralities of fingers are resiliently deformable towards parallelism with the longitudinal axis of the connector.

10. The connector defined in claim 1, wherein the connector further comprises:

a third plurality of members each forming an engagement hook.

11. The connector defined in claim 1, wherein one of the second plurality of fingers is resiliently biased to a first angle with respect to a longitudinal axis of the connector.

12. The connector defined in claim 11, wherein one of the second plurality of fingers is configured for deflection to a second angle with respect to a longitudinal axis of the connector.

13. The connector defined in claim 12, wherein one of the second plurality of fingers has a camming surface configured to engage a surface such that axial movement of the connector with respect to the surface causes the finger to

move between the first angle and the second angle.

14. The connector defined in claim 11, wherein one of the fourth plurality of fingers has an atraumatic configuration.

15. The connector defined in claim 14, wherein the atraumatic configuration is a curved portion.

16. A connector for use in connecting an end of a tubular graft conduit to a side wall of a patient's existing tubular body conduit via an aperture in the side wall thereof, comprising:

a first plurality of fingers configured to engage an interior surface of the side wall of the existing conduit;

a second plurality of fingers configured to engage an interior surface of the graft conduit and to radially expand the end portion graft conduit adjacent the existing conduit to a dimension greater than the aperture in the side wall of the existing conduit; and

a third plurality of fingers configured to pierce the end portion of the graft conduit,

wherein the pluralities of fingers are substantially radially aligned with respect to a longitudinal axis and the connector is radially deformable between a first size and a second size.

17. The connector defined in claim 16, wherein the connector is an integral unit.

18. The connector defined in claim 16, wherein one of the third plurality of fingers has barbed end portions.

19. The connector defined in claim 16, wherein one of the third plurality of fingers has a narrow neck portion

between a pair of shoulder portions for retaining a portion of the graft conduit between said shoulder portions.

20. The connector defined in claim 16, wherein the pluralities of fingers are resilient.

21. The connector defined in claim 16, wherein the first and second pluralities of fingers are resiliently deformable towards parallelism with the longitudinal axis of the connector.

22. The connector defined in claim 16, further comprising:

a fourth plurality of fingers configured to engage an exterior surface of the side wall of the existing conduit.

23. The connector defined in claim 22, wherein one of the fourth plurality of fingers is resiliently biased to a first angle with respect to a longitudinal axis of the connector.

24. The connector defined in claim 23, wherein one of the fourth plurality of fingers is configured for deflection to a second angle with respect to a longitudinal axis of the connector.

25. The connector defined in claim 24, wherein one of the fourth plurality of fingers has a camming surface configured to engage the existing conduit such that axial movement of the connector with respect to the existing conduit causes the finger to move between the first angle and the second angle.

26. The connector defined in claim 23, wherein one of the fourth plurality of fingers has an atraumatic

configuration.

27. The connector defined in claim 26, wherein the atraumatic configuration is a curved portion.

Pending Claims

1. Apparatus for connecting an axial end portion of a tubular graft conduit to a side wall of a patient's tubular body conduit via an aperture in that side wall comprising:

connector having a plurality of fingers extending from an axial end of the connector, the fingers being movable between a first configuration wherein the fingers extend radially from the connector to a second configuration wherein the fingers extend substantially axially from the connector;

mandrel sized for insertion into the end of the graft conduit to radially expand the end portion of the graft conduit, the mandrel defining a plurality of openings for receiving the fingers in the second configuration; and

a sleeve configured to surround the connector and tubular conduit and to deflect the fingers toward the second configuration to pierce the flared portion of the graft conduit and be received in the openings.

2. Apparatus defined in claim 1, wherein the fingers are configured to resiliently return to the first configuration.

3. Method of connecting an axial end portion of a tubular graft conduit to a side wall of a patient's tubular body conduit via an aperture in that side wall comprising:

providing a connector having a plurality of fingers, the fingers being movable between a first configuration wherein the fingers extend radially outward to a second configuration wherein the fingers extend substantially axially;

expanding an axial end portion of the graft conduit

to a radially flared configuration;

piercing the flared end portion of the graft conduit with the fingers from an outer surface of the graft to an inner surface of the graft while maintaining the fingers in the second configuration; and

allowing the fingers to return to the first configuration such that the end portion of the graft conduit is maintained in the radially flared configuration.

4. The method defined in claim 3, further comprising:

providing a mandrel sized for insertion into the axial end of the graft conduit to radially flare the end portion of the graft conduit,

wherein expanding the end portion of the graft comprises inserting the mandrel into the end of the graft conduit such that the end portion of the graft conduit expands to the flared configuration.

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Pending Claims

1. A connector for use in connecting an end of a tubular graft conduit to a side wall of a patient's existing tubular body conduit via an aperture in the side wall thereof, comprising:

a plurality of fingers configured to engage an interior surface of the side wall of the existing conduit, wherein one of the plurality of fingers has an end portion configured to pierce the graft conduit,

wherein the plurality of fingers is substantially radially aligned with respect to a longitudinal axis and wherein the connector is radially enlargeable in use between a first size and a second size.

2. The connector defined in claim 1, wherein each of the fingers are resilient.

3. The connector defined in claim 1, wherein each of the fingers are fabricated from a material having shape-memory characteristics.

4. The connector defined in claim 1, wherein each of the fingers are configured to move from a position substantially parallel with the longitudinal axis and a position radially outwardly disposed with respect to the longitudinal axis.

5. The connector defined in claim 1, further comprising a body portion, wherein the plurality of fingers are configured to extend at least partially radially outward from the body portion.

6. The connector defined in claim 5, wherein the body portion is radially enlargeable from a first size to a second size.

7. A connector for use in connecting an end of a tubular graft conduit to a side wall of a patient's existing tubular body conduit via an aperture in the side wall thereof, comprising:

a body portion configured to surround a portion of the graft conduit; and

a plurality of fingers configured to engage an interior surface of the side wall of the existing conduit, wherein one of the plurality of fingers has an end portion configured to pierce the graft conduit, and

wherein the connector is radially enlargeable in use between a first size and a second size.

8. The connector defined in claim 7, wherein each of the fingers are resilient.

9. The connector defined in claim 7, wherein each of the fingers are fabricated from a material having shape-memory characteristics.

10. The connector defined in claim 7, wherein the each of the fingers are configured to move from a position substantially parallel with the longitudinal axis and a position radially outwardly disposed with respect to the longitudinal axis.

11. The connector defined in claim 5, wherein the body portion is radially enlargeable from a first size to a second size.

12. A connector for use in making an artificial,

fluid-tight, hollow, annular connection between an end portion of a tubular graft conduit and a side wall of a tubular body conduit in a patient via an artificially created aperture in the side wall of the tubular body conduit so that the tubular graft conduit extends from the tubular body conduit outside of the tubular body conduit and the patient's body fluid can flow between lumens of the tubular graft conduit and the tubular body conduit via the connection, the connector comprising:

a structure which is annularly continuous and configured for disposition annularly around the outside of the tubular graft conduit;

a plurality of first members extending from the structure in an annular array which is substantially concentric with the structure, the first members being resiliently biased to extend substantially radially out from the structure and being elastically deflectable substantially parallel to a central longitudinal axis of the structure; and

a plurality of second members extending from the structure in an annular array which is substantially concentric with the structure, the second members being resiliently biased to extend substantially radially out from the structure and being elastically deflectable substantially parallel to the central longitudinal axis of the structure, the first members being configured to pass through the side wall of the tubular graft conduit at respective locations that are spaced from one another around the side wall of the tubular graft conduit, and the first and second members being further configured to reach respective locations on the side wall of the tubular body conduit that are spaced annularly around the aperture when the connector is in use and the first and second members are extending substantially radially out from the structure.

13. The connector defined in claim 12 wherein the first and second members extend from respective first and

second axially spaced portions of the structure.

14. The connector defined in claim 12 wherein when the first and second members are deflected substantially parallel to the central longitudinal axis of the structure, they extend in respective opposite directions away from the structure.

15. The connector defined in claim 12 comprising nitinol.

16. The connector defined in claim 12 wherein the first and second members are further configured for disposition on respective opposite sides of the side wall of the tubular body conduit when the connector is in use and the first and second members are extending substantially radially out from the structure.

17. The connector defined in claim 12 wherein the structure is configured for annular flexibility.

18. The connector defined in claim 12 wherein the structure is configured for axial flexibility.

19. The connector defined in claim 12 wherein the structure and the first and second members are all one piece.

20. A connector for use in connecting an end of a tubular graft conduit to a sidewall of a patient's existing tubular body conduit via an aperture in the sidewall thereof so that the patient's body fluid can flow between lumens of the graft conduit and the body conduit, comprising:

a first plurality of fingers in an annular array which can be disposed around the outside of the graft conduit substantially concentric therewith, the first plurality of

fingers being resiliently biased to extend substantially radially outward from the graft conduit and being elastically deflectable to extend substantially parallel to a longitudinal axis of the graft conduit and to point toward the end of the graft conduit so that the fingers can penetrate the graft conduit from outside the graft conduit adjacent its end, whereby when the end of the graft conduit is inserted into the aperture and the first plurality of fingers are allowed to extend radially out, they evert the end of the graft conduit inside the lumen of the body conduit.

21. The connector defined in claim 20 wherein the first plurality of fingers are additionally adapted to engage the inside of the sidewall of the body conduit adjacent the everted end of the graft conduit.

22. The connector defined in claim 20 wherein the first plurality of fingers are additionally adapted to resist removal of the everted end of the graft from the aperture.

23. The connector defined in claim 20 further comprising:

an annular structure which can be disposed around the outside of the graft conduit substantially concentric therewith, the first plurality of fingers being connected to the annular structure.

24. The connector defined in claim 20 further comprising:

a second plurality of fingers in an annular array which can be disposed around the outside of the graft conduit substantially concentric therewith, the second plurality of fingers being adapted to extend substantially radially outward from the graft conduit to engage the outside of the sidewall at locations that are distributed annularly around the

aperture.

25. The connector defined in claim 24 further comprising:

an annular structure which can be disposed around the outside of the graft conduit substantially concentric therewith, the first and second pluralities of fingers being connected to the annular structure.

26. The connector defined in claim 24 wherein the second plurality of fingers are resiliently biased to extend substantially radially outward from the graft conduit.

27. The connector defined in claim 26 wherein the second plurality of fingers are elastically deflectable to extend substantially parallel to the longitudinal axis of the graft conduit and to point away from the end of the graft conduit.

28. A method for using a connector to connect an end of a tubular graft conduit to a sidewall of a patient's existing tubular body conduit via an aperture in the sidewall thereof so that the patient's body fluid can flow between lumens of the graft conduit and the body conduit, comprising:

positioning the connector annularly around the outside of the graft conduit, wherein the connector comprises a first plurality of fingers in an annular array that are resiliently biased to extend substantially radially outward from the graft conduit in a first position;

deflecting the first plurality of fingers into a second deflected position whereby they are pointed toward the end of the graft conduit substantially parallel to a longitudinal axis of the graft conduit;

causing the first plurality of fingers to pierce the graft conduit from outside the graft conduit adjacent the end;

introducing the connector into the aperture with the first plurality of fingers in the second deflected position so that the first plurality of fingers and the end of the graft conduit are inside the lumen of the body conduit; and

allowing the first plurality fingers to assume the first position so that the first plurality of fingers evert the end of the graft conduit inside the lumen of the body conduit, engage the inside of the sidewall of the body conduit adjacent the everted end, and resist removal of the everted end from the aperture.

29. The method defined in claim 28 wherein the connector further includes an annular structure to which the fingers are connected, the positioning comprising:

disposing the annular structure substantially concentrically around the outside of the graft conduit.

30. The method defined in claim 28 wherein the connector further includes a second plurality of fingers disposed in an annular array which can be disposed around the outside of the graft conduit substantially concentric therewith, the second plurality of fingers being adapted to extend substantially radially outward from the graft conduit, the method further comprising:

extending the second plurality of fingers radially outward from the graft conduit to engage the outside of the sidewall at locations that are distributed annularly around the aperture.

31. The method defined in claim 30 wherein the connector further includes an annular structure to which the first and second pluralities of fingers are connected, the positioning comprising:

disposing the annular structure substantially concentrically around the outside of the graft conduit. —

32. The method defined in claim 30 wherein the second plurality of fingers are resiliently biased to extend substantially radially outward from the graft conduit and elastically deflectable to extend substantially parallel to the longitudinal axis of the graft conduit and to point away from the end of the graft conduit, and wherein the extending comprises:

allowing the second plurality of fingers to extend radially outward from the graft conduit.

33. The method defined in claim 32 further comprising:

introducing the connector into the aperture with the second plurality of fingers elastically deflected; and

allowing the second plurality of fingers to resiliently extend radially outward from the graft conduit to engage the outside of the sidewall at locations that are distributed annularly around the aperture.

Pending Claims

1. Apparatus for securing an axial end portion of a new length of tubing in a lumen of a patient's existing tubular body organ structure so that the lumen of the new length of tubing is partially coaxially disposed within the lumen of the existing tubular body organ structure and communicates with the lumen of the existing tubular body organ structure via an aperture in a side wall thereof to permit fluid flow between the lumens, comprising:

an anchor device, having a body portion and an attachment member, the attachment member deflected radially outwardly from the body portion and adapted for penetration of both the end portion of the new length of tubing and the existing tubular body organ structure, the body portion defining a substantially constant axial length and a cross-section expandable between a first diameter sized for insertion into the aperture in the side wall of the body conduit and a second diameter sized to secure the end portion of the new length of tubing coaxially between the anchor device and the lumen of the existing tubular structure, wherein the body portion has a plurality of axially extending members having axial lengths that remain substantially constant during radial expansion; and

a delivery device configured for coaxial insertion into the existing tubular structure and configured to expand the anchor device to the second diameter, wherein the delivery device further comprises a tapered structure positioned distal to the anchor device to facilitate introduction of the anchor device into the existing tubular structure, wherein the tapered structure partially surrounds the body portion during said introduction of the body portion into the existing tubular structure.

2. Apparatus defined in claim 1, wherein the tapered structure is relatively movable with respect to the body portion into the existing tubular structure to a position spaced apart from the body portion during the expansion thereof between the first and second diameters, and wherein the tapered structure is configured for withdrawal within and through the body portion following the expansion.

3. Apparatus defined in claim 1, wherein the anchor device has a plurality of axial members and a plurality of circumferential members connected to the axial members, each circumferential member having a first configuration and a second configuration relatively expanded with respect to the first configuration.

4. Apparatus defined in claim 3, wherein the circumferential members are deformable between the first and the second configuration.

5. Apparatus defined in claim 4, wherein the anchor device is configured such that the deformation of the circumferential members produces relative radial displacement of adjacent axial members with respect to one another.

6. Apparatus defined in claim 3, wherein the first configuration of the circumferential members is substantially serpentine.

7. Apparatus defined in claim 1, wherein the anchor device defines an aperture configured to receive a suture for securing the end portion of the new length of tubing to the anchor device.

8. Apparatus defined in claim 1, wherein the anchor device defines a longitudinal axis movable between a

substantially straight configuration and a curvilinear configuration such that the cross-section remains substantially unchanged in said configurations.

9. Apparatus defined in claim 8, wherein the anchor device comprises a plurality of axial members, each having an expansion link to permit elongation of the respective axial member.

10. Apparatus defined in claim 9, wherein the expansion link is configured for independent expansion with respect to an adjacent expansion link.

11. Apparatus defined in claim 9, wherein the expansion link is plastically deformable between a compressed and an expanded configuration.

12. Apparatus defined in claim 11, wherein the expansion link has a substantially "V"-shaped configuration.

13. Apparatus defined in claim 12, wherein the expansion link extends radially outward and is configured to receive a suture for securing the graft conduit to the anchor device.

14. Apparatus defined in claim 1, wherein the anchor device comprises a positioning member extending radially outward from said anchor device and configured to engage the side wall of the existing tubular structure.

15. Apparatus defined in claim 1, wherein the anchor device comprises a positioning member extending radially outward from said anchor device and positioned at a predetermined location along the axial length thereof and configured to engage the side wall of the existing tubular

structure when the anchor device has been inserted a predetermined distance into the existing tubular structure.

16. Apparatus defined in claim 1, wherein the anchor device comprises a positioning member extending radially outward from said anchor device and positioned at a predetermined location along the axial length thereof and configured to provide a tactile indication to a user upon engagement with the side wall of the existing tubular structure when the anchor device has been inserted a predetermined distance into the existing tubular structure.

17. Apparatus defined in claim 8, wherein the anchor device comprises a plurality of axial members configured for relative radial movement and differential axial elongation with respect to adjacent axial members.

18. Apparatus defined in claim 17, wherein the axial members are interconnected by circumferential members deformable between a compressed and an expanded configuration.

19. Apparatus defined in claim 18, wherein each of the axial members has an expansion link configured to allow elongation of the axial member.

20. Apparatus defined in claim 1, further comprising:

a delivery device configured for coaxial insertion into the existing tubular structure and configured to expand the anchor device to the second diameter.

21. Apparatus defined in claim 20, wherein the delivery device further comprises a tapered structure positioned distal to the anchor device to facilitate introduction of the anchor device into the existing tubular

structure.

22. Apparatus defined in claim 20, wherein the delivery device defines an axial bore, and the apparatus further comprises:

an elongated guide structure slidably received in the axial bore and configured for insertion into the existing tubular structure.

23. Apparatus defined in claim 1, wherein the attachment member is plastically deformable to the position deflected radially outwardly from the body portion.

24. Apparatus defined in claim 1, wherein the attachment member is configured to receive a suture for attaching the new length of tubing to the anchor device.

25. Apparatus defined in claim 1, wherein the body portion has an articulation cell that allows the body portion to conform to a curve of the existing tubular body organ structure.

Pending Claims

1. A method of installing tubular graft conduit between first and second spaced locations in a patient's tubular body structure, comprising:

providing an aperture through a wall of the tubular body structure at the first location with a distal portion of an elongated structure inserted into and along a lumen of the tubular body structure to the first location;

providing a graft having first and second connectors attached to axial ends of the graft;

passing the graft along the lumen of the tubular body structure through the wall at one of the first and second locations to the other of the locations; and

attaching axial end portions of the graft to the tubular body structure adjacent the first and second locations by annularly expanding the first and second connectors.

2. The method defined in claim 1, wherein the step of attaching axial end portions of the graft to the tubular body structure by annularly expanding the first and second connectors comprises expanding first and second expandable structures positioned adjacent the interiors of the first and second connectors.

3. The method defined in claim 1, wherein the step of attaching axial end portions of the graft to the tubular body structure comprises:

annularly expanding a first axial portion of the first connector spaced furthest from the first location;

inserting a second axial portion of the first connector into the tubular body structure at the first location such that the first, expanded portion of the first connector remains outside the tubular body structure; and

annularly expanding the second axial portion of the first connector positioned inside the tubular body structure at the first location.

4. The method defined in claim 3, wherein a distal portion of the elongated structure defines an interior lumen, and the step of providing the aperture through the tubular body structure at the first location with the distal portion of the elongated structure comprises:

extending the distal end portion of the elongated structure out of the aperture of the tubular body structure at the first location such that a fluid-tight seal is provided between the distal portion of the elongated structure and the aperture.

5. The method defined in claim 4, wherein the step of passing the graft along the lumen of the tubular body structure through the wall at one of the first and second locations comprises:

passing the graft along the lumen of the elongated structure and out of the elongated structure at the distal end portion thereof.

6. The method defined in claim 5, wherein the step of passing the graft comprises:

passing the graft through the wall of the tubular body structure at one of the first and second locations such that the second connector is positioned adjacent the second location and the first connector is positioned adjacent the first location and is extending outside the first elongated structure.

7. The method defined in claim 5, further comprising:

providing a second elongated structure having a lumen, coaxially positioned to surround an axial portion of the first connector.

8. The method defined in claim 7, further comprising:

before the step of annularly expanding the first axial portion of the first connector spaced furthest from the first location, exposing the first axial portion of the first connector from the lumen of the second elongated structure while retaining the second axial portion within the lumen of the second elongated structure.

9. The method defined in claim 8, further comprising:

before the step of inserting a second axial portion of the first connector into the tubular body structure at the first location, retracting the distal end portion of the first elongated structure into the tubular body structure.

10. The method defined in claim 8, further comprising:

before the step of annularly expanding the second axial portion of the first connector positioned inside the tubular body structure at the first location, exposing the second portion of the first connector from the lumen of the second elongated structure.

Pending Claims

1. Instrumentation for facilitating cutting an opening in a side wall of a body conduit comprising:

a tubular structure defining a lumen and having a sharpened distal end portion configured to cut a section of the body conduit to create the opening; and

a tissue holding structure axially movable within the lumen of the tubular structure, the tissue holding structure comprising a piercing portion to permit passage of the tissue holding structure through the body conduit from an entrance side adjacent the tubular structure to an exit side thereof, and a retention member to secure the section of the body conduit to the tissue holding structure during movement of the tissue holding structure to approximate the entrance side of the section of the body conduit and the sharpened distal portion of the tubular structure which cuts the section of body conduit.

2. The instrumentation as defined in claim 1, wherein the tissue holding structure and the section of body conduit secured thereto by the retention member are movable into the lumen of the tubular structure.

3. The instrumentation as defined in claim 1, wherein the retention member is a barb that is resiliently biased radially outwardly in order to secure the section of body conduit.

4. The instrumentation as defined in claim 3, wherein the barb is deflected radially inwardly during the distal passage of the tissue holding structure through the section of the body conduit.

5. The instrumentation as defined in claim 4, wherein the piercing portion comprises a needle catheter having a sharpened distal end portion to permit passage of the tissue holding structure through the section of body conduit.

6. The instrumentation as defined in claim 5, wherein the tissue holding structure further comprises a barb support member which supports the barb thereon and is axially movable within an internal lumen of the needle catheter.

7. The instrumentation as defined in claim 6, wherein the needle catheter is sized to deflect the barb radially inwardly during distal movement of the barb support member through the internal lumen of the needle catheter, and which allows the barb to return to an outwardly extending orientation after passage through the internal lumen.

8. The instrumentation as defined in claim 6, wherein the barb support member has an atraumatic distal tip portion.

9. The instrumentation as defined in claim 6, wherein the barb support member extends distally from a flexible catheter.

10. The instrumentation as defined in claim 1, wherein the sharpened distal end portion of the tubular structure is configured to cut the section of body conduit by axial rotation of the tubular structure.

11. The instrumentation as defined in claim 1, wherein the sharpened distal end portion of the tubular structure is configured to cut the section of body conduit by longitudinal advancement of the tubular structure through the body conduit.

12. The instrumentation as defined in claim 1, further comprising:

a connector for providing an anastomosis between the body conduit and a new length of body tubing comprising a first plurality of fingers for engaging an inner wall of the body conduit, a second plurality of fingers for engaging an outer wall of the body conduit, and a plurality of engagement members for securing the new length of body tubing to the connector.

13. The instrumentation as defined in claim 12, wherein the first plurality of fingers, the second plurality of fingers, and the engagement members are resiliently disposed radially outward.

14. The instrumentation as defined in claim 13, further comprising:

a connector support defining a longitudinal axis and having a first retention structure to retain the first plurality of fingers towards parallelism with the longitudinal axis and a second retention structure to retain the second plurality of fingers towards parallelism with the longitudinal axis, such that the engagement members are disposed radially outwardly to facilitate attachment of the new length of tubing thereto by piercing the new length of tubing.

15. The instrumentation as defined in claim 14, wherein the connector support defines an interior lumen for receiving the tubular structure and tissue holding structure therethrough.

16. The instrumentation as defined in claim 14, wherein the first retention structure is an annular sleeve for retaining the first plurality of fingers distally towards

parallelism with the longitudinal axis.

17. The instrumentation as defined in claim 16, wherein the first retention structure retains the first plurality of fingers in a configuration having a dimension smaller than the opening in the body conduit.

18. The instrumentation as defined in claim 14, wherein the second retention structure is a member having a projection received in a corresponding opening in each of the second plurality of fingers to retain the second plurality of fingers towards parallelism with the longitudinal axis.

19. The instrumentation as defined in claim 14, wherein the second retention structure is an annular sleeve to retain the second plurality of fingers towards parallelism with the longitudinal axis.

20. The instrumentation as defined in claim 12, wherein the new length of tubing has a direction of natural fluid flow, the instrumentation further comprising:

a sleeve sized for passage within the new length of tubing having a tapered tip portion to provide a visual indication of the direction of natural fluid flow.

21. The instrumentation as defined in claim 14, further comprising:

a pressure-application tool for facilitating the piercing of the new length of tubing by individual ones of the engagement members to secure the new length of tubing to the connector, the pressure-application tool having a distal sleeve portion with an internal lumen sized such that individual ones of the engagement members may be received therein, the sleeve providing substantially uniform pressure to the new length of tubing about the engagement member to

pierce the new length of tubing by the engagement member.

22. A method for cutting an opening in a body conduit comprising:

providing a tissue holding structure having a retention member to secure a section of the body conduit to the tissue holding structure;

securing the retention member to the section of the body conduit by at least partially inserting the tissue holding structure into the body conduit;

providing a tubular structure having a sharpened distal portion;

approximating the body conduit and the sharpened distal portion of the tubular structure by relative movement of the tissue holding structure towards the tubular structure; and

cutting the section of the body conduit with the sharpened distal portion of the tubular body structure to provide an opening in the body conduit.

23. The method as defined in claim 22, wherein the tubular structure defines an internal lumen, the method further comprising:

after cutting the section of the body conduit, withdrawing the tissue holding structure and the section of the body conduit into the internal lumen of the tubular structure.

24. The method as defined in claim 22, wherein cutting the section of the body conduit comprises angularly rotating the tubular structure while contacting the section of body conduit.

25. The method as defined in claim 22, wherein cutting the section of the body conduit comprises

longitudinally advancing the tubular structure through the section of body conduit.

26. The method as defined in claim 22, wherein the retention member is a barb that is resiliently biased radially outwardly in order to secure the tissue holding structure to the body conduit and capable of deflection radially inwardly, and

wherein securing the retention member to the body conduit comprises maintaining the barb radially inwardly while inserting the tissue holding structure into the body conduit, and subsequently allowing the barb to deflect radially outwardly to engage the body conduit.

27. The method as defined in claim 22, wherein the tissue holding structure further comprises a piercing portion, and

wherein securing the retention member to the body conduit comprises piercing the body conduit with the piercing portion of the tissue holding structure.

28. The method as defined in claim 27, wherein the piercing portion comprises a needle catheter having a sharpened distal end portion, and wherein piercing the body conduit comprises piercing the body conduit from an entrance side to an exit side with the needle catheter.

29. The method as defined in claim 28, wherein the tissue holding structure further comprises a barb support member which supports the barb thereon and is axially movable within an internal lumen of the needle catheter, and

wherein the securing further comprises passing the barb support member and the barb through the internal lumen of the needle catheter from the entrance side to the exit side.

30. The method as defined in claim 29, wherein the needle catheter is sized to deflect the barb radially inwardly during distal movement of the barb support member through the internal lumen of the needle catheter.

31. The method as defined in claim 30, wherein the securing the retention member to the body conduit further comprises allowing the barb to return to a configuration wherein the retention member is positioned radially outwardly in order to secure the body conduit thereby.

32. The method as defined in claim 29, wherein the barb support member extends distally from a flexible catheter and

wherein securing the tissue holding member to the body conduit further comprises advancing the catheter towards the body conduit.

33. The method as defined in claim 32, wherein the approximating the body conduit and the sharpened portion of the tubular structure comprises withdrawing the catheter away from the body conduit.

34. A method for performing an anastomosis between a body conduit and a new length of tubing comprising:

providing a tissue holding structure having a retention member to secure a section of the body conduit to the tissue holding structure;

securing the retention member to the section of the body conduit by at least partially inserting the tissue holding structure into the body conduit;

providing a tubular structure having a sharpened distal portion;

approximating the body conduit and the sharpened distal portion of the tubular structure by relative movement

of the tissue holding structure towards the tubular structure;

cutting the section of the body conduit with the sharpened distal portion of the tubular body structure to provide an opening in the body conduit; and

attaching the new length of tubing to the body conduit adjacent the opening made by the cutting.

35. The method as defined in claim 34, further comprising:

providing a connector defining a central opening and comprising a first plurality of fingers for engaging an inner wall of the body conduit, a second plurality of fingers for engaging an outer wall of the body conduit, and a plurality of engagement members for securing a portion of the new length of body tubing to the connector, wherein attaching the new length of tubing to the body conduit adjacent the opening comprises securing a portion of the new length of body tubing to the connector with the plurality of engagement members, engaging the inner wall of the body conduit with the first plurality of fingers, and engaging the outer wall of the body conduit with the second plurality of fingers.

36. The method as defined in claim 35, further comprising:

providing a connector support defining a longitudinal axis and having a first retention structure for retaining at least one finger of the first plurality of fingers towards parallelism with the longitudinal axis; and

prior to securing the portion of the new length of tubing to the connector, mounting the connector coaxially about the connector support and retaining the at least one finger of the first plurality of fingers with the retention structure.

37. The method as defined in claim 49, wherein

mounting the connector coaxially about the connector support further comprises retaining the first plurality of fingers towards parallelism with the longitudinal axis and retaining the second plurality of fingers towards parallelism with the longitudinal axis such that the engagement members are disposed radially outwardly to facilitate attachment of the new length of tubing thereto.

38. The method as defined in claim 37, wherein the first retention structure is an annular sleeve, and wherein mounting the connector coaxially about the connector support further comprises retaining the first plurality of fingers distally towards parallelism with the longitudinal axis.

39. The method as defined in claim 37, wherein the mounting the connector coaxially about the connector support further comprises retaining the first plurality of fingers in a configuration having a diameter smaller than the opening in the body conduit.

40. The method as defined in claim 37, wherein the second retention structure is a member having a tab received in a corresponding opening in each of the second plurality of fingers.

41. The method as defined in claim 35, wherein the new length of tubing has a direction of natural fluid flow, the method further comprising:

providing a sleeve sized for passage within the new length of tubing having a tapered tip portion to provide a visual indication of the direction of natural fluid flow; and

before securing the portion of the new length of tubing to the connector, advancing the new length of tubing over the sleeve such that new length of tubing may be attached to the connector based on the direction of natural fluid flow.

42. The method as defined in claim 35, further comprising:

providing a pressure-application tool having a distal sleeve portion with an internal lumen sized such that individual ones of the engagement members may be received therein, wherein securing the portion of the new length of tubing to the connector comprises providing substantially uniform pressure by the sleeve portion to the new length of tubing about the engagement member to facilitate piercing of the new length of tubing by the engagement member.

43. The method as defined in claim 40, wherein the member is a tubular sheath, the method further comprising:

after securing the new length of tubing to the connector, releasing the second plurality of fingers from the tabs and advancing the tubular sheath such that the second plurality of fingers are deflected towards parallelism with the longitudinal axis in a substantially opposite direction than prior to the releasing.

44. The method as defined in claim 43, wherein attaching the new length to tubing to the body conduit adjacent the opening further comprises:

inserting the first plurality of fingers into the opening;

releasing the first retention structure to allow the first plurality of fingers to engage the inner wall of the body conduit; and

releasing the second retention structure to allow the second plurality of fingers to engage the outer wall of the body conduit.

45. Apparatus for inserting a distal portion of a hollow annular anastomotic connector into an aperture in a side wall of a body tissue conduit in a patient comprising:

a structure having an exterior surface that is reconfigurable, in use, from an early configuration to a subsequent configuration, the early configuration having annular periphery, wherein the diameter of the annular periphery in the early configuration gradually increases from a first relatively small value at a distal end of the early configuration to a second relatively large value at a more proximal portion of the early configuration, and the subsequent configuration having annular periphery, wherein the diameter of the annular periphery in the subsequent configuration is substantially free of abrupt increases in the distal direction, the structure at the more proximal portion of the early configuration defining an annular hollow that is open in the proximal direction for substantially concentrically receiving the distal portion of the connector.

46. The apparatus defined in claim 45 wherein the structure is further configured so that in the subsequent configuration the distal portion of the connector is no longer disposed in the annular hollow.

47. The apparatus defined in claim 45 wherein the structure is further configured so that in the subsequent configuration the structure can be withdrawn from the patient by pulling it proximally through the connector.

48. The apparatus defined in claim 45 wherein the structure is further configured to convert from the early configuration to the subsequent configuration while inside the lumen of the body tissue conduit and without injuriously deforming the body tissue conduit.

49. The method as defined in claim 36, wherein the connector support further comprises a second retention structure such that the engagement members are disposed

radially outwardly to facilitate attachment of the new length of tubing thereto.

Pending Claims

1. An anastomosis delivery system for delivering a connector having at least one backwards spike having a bent tip, comprising:

a hollow guide sheath; and

a hollow, axially slotted section, fitting within said sheath, said section having a flared configuration and an unflared configuration and wherein said axially slotted section is adapted to contain at least a part of said connector and to limit axial motion of said connector when said section is in its unflared configuration.

2. A system according to claim 1, wherein axially moving said section selectively advances said spike.

3. A system according to claim 1, wherein axially moving said section selectively retracts said spike.

4. A system according to claim 1, wherein said slotted section maintains said bent tip in a bent configuration.

5. A system according to claim 1, wherein said slotted section includes at least one receptacle for engaging said bent tip.

6. A system according to claim 5, wherein said receptacle comprises an inner lip of said section, adapted for catching said tip.

7. A system according to claim 5, wherein said receptacle comprises a hole in said section, for engaging said

tip.

8. A system according to claim 1, wherein said section comprises a second, inner tube and wherein said inner tube and said slotted section define between them a receptacle for a bent section of at least one bent spike of connector.

9. A system according to claim 8, wherein said receptacle is a space between tips of said slotted section and said inner tube.

10. A system according to claim 7, wherein said receptacle is an opening in said inner tube.

11. A system according to claim 7, wherein said slotted section and said inner tube grip between them a part of said connector.

12. A system according to any of claims 1-11 wherein said slotted section comprises a capsule closed at one end.

13. An anastomosis delivery system for delivering a connector having at least one backwards spike having a bent tip, comprising:

a hollow guide sheath;

an apertured inner tube fitting within said sheath; and

a plurality of spike locking elements disposed between said guide sheath and said apertured inner tube, wherein said spike locking elements, when extended, are adapted to grip a part of said anastomosis connector between said inner tube and said locking elements and wherein said apertures are each adapted to receive a said bent tip of said anastomosis connector.

14. A method of mounting an anastomosis connector having a plurality of bent backwards spikes including bent tips, into a delivery tube, comprising:

bending back said spikes to point backwards along an axial direction of said connector, away from a graft mounted on said connector;

maintaining said tips in a bent configuration; and

inserting said spikes into a receptacle of said delivery tube by pushing back each spike, using a jig, into said receptacle, and locking said spike tip in said receptacle, which receptacle maintains said tips in a bent configuration.

15. A rotating punch, comprising:

a sharp, central guide wire; and

a rotating outer tube having a vascular cutting edge defined by a lip of said tube, wherein said outer tube has an increasing outer diameter, away from said cutting edge.

16. Apparatus for anastomosis, comprising:

a delivery system includes conical shaped arrangement of puller spikes; and

a cone shaped body defining an opening at either end, a wide opening, at abase thereof, for receiving said conical arrangement and a narrow opening, at an apex thereof, for insertion into a blood vessel.

17. Apparatus according to claim 16, wherein said cone shaped body is pre-split axially.

18. Apparatus according to claim 16, comprising a cutting mechanism adapted to fit in said cone and comprising at least one cutting blade that fits through said narrow opening said cone.

19. Apparatus according to any of claims 16-18, wherein said cone is at least partially pre-split from an apex thereof.

20. Apparatus according to claim 19, wherein said cone is pre-split on opposite sides.

21. A removable graft guide for a graft delivery system, comprising:

a body removably mounted on said delivery system; and

a guide portion adapted to fit in an aperture in said graft delivery system and prevent contact between a graft inserted through said aperture and damaging parts of said delivery system.

22. A guide according to claim 21, wherein said body is adapted to be mounted on an outside of said delivery system.

23. A guide according to claim 21 or claim 22, wherein said body comprises a collar for preventing distortion of a delivery end of said delivery system.

24. A vessel puller, comprising:

a shaft adapted to be inserted in a bore of a tubular gaft delivery system having a delivery end;

a vessel engager mounted on one end of the shaft and adapted to engage a tip of a graft; and

a handle attached to another end of said shaft.

25. A puller according to claim 24, wherein the shaft is longer than a distance between an aperture in the side of said bore and said delivery end, such that said handle can be comfortably held by a person while a graft is inserted through said aperture, by said person, to be engaged by said

vessel engager.

26. A puller according to claim 24, wherein said vessel engager is adapted to engage a graft end from a side of said engager.

27. A puller according to any of claims 24-26, wherein said shaft is flexible.

28. A combined hole punching and graft delivery device, comprising:

a body, having therein at least one recess for receiving a spike of a connector; and

a sharp tip retractable relative to said body, wherein said sharp tip and said body define between them a blood vessel wall receiving area.

29. A device according to claim 28, wherein said spike is pre-stressed to self extend out of said recess.

30. A device according to claim 28, wherein said spike radially extends out of said recess when it is retracted.

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Pending Claims

1. Method for making an anastomotic connection between a first opening in a side wall of a first vessel and a second opening in a side wall of a second vessel, comprising:

providing a connector structure having a first end portion configured to engage the first vessel and a second end portion configured to engage the second vessel, the connector structure being plastically deformable from a first configuration to a second configuration having an enlarged annular dimension;

providing a balloon having an expanded configuration defining a substantially large diameter adjacent the distal end thereof;

making the first opening in the side wall of the first vessel;

attaching the first vessel to the connector structure;

making the second aperture in the side wall of the second vessel;

providing an introduction structure for the connector structure comprising a first introduction configuration and a second removal configuration having smooth proximal surface;

inserting the introduction structure along with the second end portion of the connector structure into the second opening; and

attaching the first vessel to the second vessel adjacent the first and second openings to form a fluid-tight anastomotic connection therebetween by annularly enlarging the connector structure to the second configuration with the distal end portion of the balloon.

2. Method as defined in claim 1, wherein making the opening in the side wall of one of the first and the second vessels comprises:

making an incision in the side wall of the vessel; and

dilating the incision to a dimension substantially equal to an internal diameter of the connector structure.

3. Method as defined in claim 1, wherein making the first opening in the side wall of the first vessel comprises making an incision in the side wall of the first vessel having a dimension substantially equal to an internal diameter of the second vessel.

4. Method as defined in claim 1, wherein providing the connector structure further comprises providing a first plurality of members at said first end portion having free ends configured to penetrate the side wall of the first vessel at locations that are annularly spaced about the first opening.

5. Method as defined in claim 4, wherein attaching the first vessel to the connector structure further comprises penetrating the side wall of the first vessel at locations that are annularly spaced about the first aperture with the free ends of the plurality of second members.

6. Method as defined in claim 1, further comprising:

providing a ring structure having a body portion defining a substantially toroidal shape configured for placement about the first opening in the side wall of the first vessel, the ring structure having an inner diameter which is sized to cover the periphery of the first opening and an outer diameter which is sized to substantially inhibit insertion thereof into the second aperture of the second vessel during the inserting.

7. Method as defined in claim 6, further comprising:

after attaching the connector structure in the first configuration to the first vessel, positioning the ring structure about the aperture in the side wall of the first vessel.

8. Method as defined in claim 1, wherein inserting the second end portion of the connector structure into the second opening comprises inserting the connector structure substantially parallel to an internal lumen of the second conduit

9. Method as defined in claim 1, which further comprises:

after inserting the second end portion of the connector structure into the second opening substantially parallel to the internal lumen of the second conduit, moving to the connector structure to a configuration substantially perpendicular to the internal lumen of the second conduit.

10. Method as defined in claim 1, wherein the introduction structure further comprises a first configuration with a tapered portion configured to surround the second end portion of the connector structure,

wherein inserting the second end portion of the connector structure into the second opening comprises inserting the tapered portion into the aperture of the second vessel while in a surrounding configuration with respect to the connector structure, and unfolding the introduction structure to a second configuration to expose the second end portion of the connector structure.

11. Method as defined in claim 1, wherein the introduction structure further comprises a first configuration with a tapered portion configured to surround the second end portion of the connector structure,

wherein inserting the second end portion of the connector structure into the second opening comprises inserting the tapered portion into the aperture of the second vessel while in a surrounding configuration with respect to the connector structure, and advancing the tapered portion distally to a position spaced apart from the connector structure.

12. Method as defined in claim 11, wherein providing the introduction structure further comprises providing an intermediate portion proximal of the tapered structure that is flexible between a folded first configuration, defining a recess for receiving the second portion of the connector structure, and an unfolded second configuration, and an elongated tubular structure proximal of the intermediate structure configured to extend proximally within an internal lumen of the first conduit,

wherein the inserting the tapered portion into the aperture of the second vessel comprises positioning the

elongated tubular structure within the internal lumen of the first conduit and positioning the second end portion of the connector in the recess of the intermediate portion, and

wherein the advancing the tapered portion comprises advancing the tapered portion such that the elongated tubular portion remains substantially stationary and the intermediate portion is unfolded from the folded first configuration to the unfolded second configuration.

13. Method as defined in claim 12, wherein the tapered structure, the intermediate portion, and the elongated tubular structure are in fluid communication,

wherein advancing the tapered portion comprises introducing fluid into the tapered structure and the intermediate portion through the elongated tubular structure.

14. Method as defined in claim 1, further comprising:

providing a balloon structure having a balloon configured for expansion within the connector structure,

wherein attaching the first vessel to the second vessel by annularly enlarging the connector structure comprises inflating the balloon disposed inside the connector structure.

15. Method as defined in claim 14, wherein inflating the balloon disposed inside the connector structure comprises inflating the balloon such that the connector structure is positioned adjacent the distal end of the balloon at a distance less than an internal diameter of the second vessel.

16. Method as defined in claim 14, wherein the balloon has an expanded configuration defining a substantially large diameter adjacent a distal end thereof, and

wherein inflating the balloon disposed inside the connector structure comprises inflating the balloon such that the connector structure is positioned at about 2.5 mm from the distal end of the balloon.

17. Method as defined in claim 1, wherein providing the connector structure further comprises providing a second plurality of members at said second end portion having free ends configured to engage the side wall of the second vessel at locations that are annularly spaced about the second opening.

18. Method as defined in claim 17, wherein attaching the first vessel to the second vessel further comprises engaging the side wall of the second vessel at locations that are annularly spaced about the second aperture with the free ends of the plurality of second members.

19. Method as defined in claim 1, wherein providing a connector structure comprises providing the first and second end portions that are annularly enlargeable to a greater extent than the remainder of the connector structure,

wherein attaching the first vessel and the second vessel by annularly enlarging the connector structure comprises annularly enlarging the first and second end portions to a greater extent than the remainder of the connector structure, wherein the first and second end portions are approximated.

20. Method as defined in claim 1, further comprising:

after attaching the first and second vessels, closing the end portion of the first vessel.

21. System for making an anastomotic connection

between a first opening in a side wall of a first vessel and a second opening in a side wall of a second vessel, comprising:

a connector structure having a first end portion configured for attachment to the first vessel and a second end portion configured to engage the second vessel, the connector being plastically deformable from a first configuration to a second configuration having an enlarged annular dimension substantially equivalent to an internal diameter of the second vessel;

a balloon structure having a balloon configured for positioning within the connector structure to enlarge the connector structure from the first configuration to the second configuration, the balloon structure configured to define a substantially large diameter adjacent to the distal end thereof; and

an introduction structure comprising a first configuration having a tapered portion for introduction into the second opening and defining a recess for surrounding the second end portion of the connector structure during said introduction into the second opening, and a second configuration having a smaller dimension and a smooth proximal surface, wherein the introduction structure is configured to move to the second configuration to expose the second end portion of the connector structure.

22. System as defined in claim 21, wherein the connector structure further comprises a first plurality of members at said first end portion having free ends configured to penetrate the side wall of the first vessel at locations that are annularly spaced about the first opening.

23. System as defined in claim 21, further comprising:

a ring structure having a body portion configured for placement about the first opening, the ring structure

having an inner diameter which is sized to cover the side wall of the first vessel about the periphery of the first opening, and an outer diameter which is sized to substantially inhibit passage of the first vessel into the second opening.

24. System as defined in claim 21, further comprising:

a ring structure having a body portion configured for placement about the first opening, which provides a visual indication of the first opening.

25. System as defined in claim 21, wherein a portion of the introduction structure is flexible between a substantially straight configuration and a configuration defining an angle of about 90 degrees.

26. System as defined in claim 21, wherein the introduction structure further comprises an intermediate portion proximal of the tapered portion, the intermediate portion defining the recess for receiving the second end portion of the connector structure in the first configuration and capable of being unfolded in the second configuration, and an elongated tubular structure proximal of the intermediate structure configured to extend proximally within an internal lumen of the first conduit.

27. System as defined in claim 26, wherein the tapered portion is configured for advancement such that the elongated tubular portion remains substantially stationary and the intermediate portion is unfolded from the folded configuration to the unfolded configuration.

28. System as defined in claim 27, wherein the tapered structure, the intermediate portion, and the elongated tubular structure define a common internal space in fluid

communication.

29. System as defined in claim 28, wherein introduction structure is configured such that introduction of fluid into the common internal space causes distal advancement of the tapered structure.

30. System as defined in claim 28, wherein introduction structure is configured such that introduction of fluid into the common internal space causes simultaneous movement of the intermediate portion from the folded configuration to the unfolded configuration and distal advancement of the tapered structure.

31. System as defined in claim 21, wherein the balloon has an expanded configuration defining a substantially large diameter adjacent a distal end thereof, and

wherein inflating the balloon disposed inside the connector structure comprises inflating the balloon such that the connector structure is positioned adjacent the distal end of the balloon.

32. System as defined in claim 21, wherein the first and second end portions of the connector structure are configured for annular enlargement to a greater extent than the remainder of the connector structure.

33. System as defined in claim 21, wherein the connector structure comprises a first axial length in the first configuration and a second, shorter axial length in the second configuration.

34. System as defined in claim 21, wherein the connector structure further comprises a second plurality of members at said second end portion having free ends configured

to penetrate the side wall of the second vessel at locations that are annularly spaced about the second opening.

67. The method of making a hollow annular anastomotic connection between a portion of a side wall of a tubular graft conduit and a side wall of a tubular body tissue conduit in a patient so that body fluid can flow through the connection between a lumen of the graft conduit and a lumen of the tubular body tissue conduit, the graft conduit having first and second portions that extend axially along the graft conduit in respective opposite directions away from the portion of the side wall of the graft conduit, the first portion being used for body fluid flow after the connection has been made, and the second portion having a severed end spaced from the portion of the side wall of the graft conduit, comprising:

inserting instrumentation for making the connection into the lumen of the second portion so that the instrumentation extends between the severed end and the portion of the side wall of the graft conduit.

68. The method defined in claim 67 further comprising:

causing a portion of the instrumentation to extend through the portion of the side wall of the graft conduit.

69. The method defined in claim 68 further comprising:

further causing the portion of the instrumentation to pass through the side wall of the body tissue conduit.

70. The method defined in claim 69 further comprising:

providing the portion of the instrumentation with a hollow annular connector.

71. The method defined in claim 70 further comprising:

engaging with a first portion of the connector the portion of the side wall of the graft conduit, the engaging being in a first hollow annular pattern that is substantially concentric with the connector.

72. The method defined in claim 71 further comprising:

using the instrumentation to position the connector so that a second portion of the connector can engage the side wall of the body tissue conduit in a second hollow annular pattern that is substantially concentric with the connector.

73. The method defined in claim 72 further comprising:

further using the instrumentation to cause the second portion of the connector to engage the side wall of the body tissue conduit in the second hollow annular pattern.

74. The method defined in claim 73 wherein the further using comprises:

employing the instrumentation to change in shape at least some parts of the connector.

75. The method defined in claim 74 wherein the employing comprises:

annularly enlarging the connector.

76. The method defined in claim 74 wherein the employing comprises:

deflecting first parts of the connector radially out relative to second parts of the connector.

77. The method defined in claim 74 wherein the

employing comprises:

causing the first and second portions of the connector to move toward one another substantially parallel to an axis about which the connector is annular.

78. The method defined in claim 74 wherein the employing comprises:

causing the first and second portions of the connector to press together hollow annular portions of the portion of the side wall of the graft conduit and the side wall of the body tissue conduit.

79. The method defined in claim 73 further comprising:

after the further using, withdrawing the instrumentation from the connector and from the patient via the severed end.

80. The method defined in claim 79 further comprising:

after the withdrawing, closing the lumen of the second portion of the graft conduit.

81. The method defined in claim 74 wherein the instrumentation comprises an inflatable balloon around which the connector is annularly disposed, and wherein the employing comprises:

inflating the balloon.

82. The method defined in claim 81 further comprising:

after the inflating, deflating the balloon; and

after the deflating, withdrawing the instrumentation from the connector and from the patient via the severed end.

83. The method defined in claim 82 further comprising:

after the withdrawing, closing the lumen of the second portion of the graft conduit.

84. The method defined in claim 72 wherein the instrumentation includes a substructure configured to selectively cover the second portion of the connector, and wherein the using comprises:

employing the substructure to cover the second portion of the connector until the second portion of the connector is positioned where it can be made to engage the side wall of the body tissue conduit in the second hollow annular pattern; and

operating the substructure to uncover the second portion of the connector.

85. The method defined in claim 84 wherein the substructure comprises an inflatable balloon configured to cover the second portion of the connector prior to inflation, and wherein the operating comprises:

inflating the balloon.

86. A method of making a graft connection between first, second, and third portions of a patient's body tissue conduit system, the first portion supplying body fluid to the graft, and the second and third portions receiving body fluid from the graft comprising:

supplying a graft conduit;

forming a first hollow annular anastomotic connection between a first location along the graft conduit and the first portion of the body tissue conduit system so that body fluid can flow from the first portion into the graft conduit at the first location via the first connection;

using a first hollow annular connector to form a

second hollow annular anastomotic connection between apertures in a side wall of the graft conduit at a second location along the graft conduit and in a side wall of the second portion of the body tissue conduit system so that body fluid can flow from the graft conduit into the second portion via the second connection; and

using a second hollow annular connector to form a third hollow annular anastomotic connection between apertures in the side wall of the graft conduit at a third location along the graft conduit and in a side wall of the third portion of the body tissue conduit system so that body fluid can flow from the graft conduit into the third portion via the third connection.

87. The method defined in claim 86 wherein the graft conduit has a severed end; wherein the first location, the second location, the third location, and the severed end are in that order along the graft conduit; and wherein the using a second hollow annular connector comprises:

introducing the second connector into the graft conduit via the severed end.

88. The method defined in claim 87 wherein the using a second hollow annular connector further comprises:

passing the second connector inside the graft conduit from the severed end to the third location until a first portion of the second connector extends through the aperture at the third location, while a second portion of the second connector remains inside the graft conduit adjacent the aperture at the third location.

89. The method defined in claim 88 wherein the using the second connector further comprises:

engaging the second portion of the second connector with the side wall of the graft conduit annularly around the

aperture at the third location.

90. The method defined in claim 89 wherein the using the second connector further comprises:

approximating the aperture at the third location with the aperture in the third portion of the body tissue conduit system; and

inserting the first portion of the second connector into the aperture in the third portion of the body tissue conduit system

91. The method defined in claim 90 wherein the using the second connector further comprises:

engaging the first portion of the second connector with the side wall of third portion of the body tissue conduit system annularly around the aperture in that portion of the body tissue conduit system.

92. The method defined in claim 91 wherein the using the second connector further comprises:

deforming at least parts of the second connector after the inserting.

93. The method defined in claim 92 wherein the deforming comprises:

causing parts of the second connector to increase in radial outward extension.

94. The method defined in claim 92 wherein the deforming comprises:

annularly expanding the second connector.

Pending Claims

1. The method of making a graft connection between first and second portions of a patient's tubular body tissue conduit system comprising:

supplying a length of tubular graft conduit having first and second severed ends;

forming a first aperture in a side wall of the graft conduit adjacent the first severed end;

forming a second aperture in the side wall of the graft conduit adjacent the second severed end;

forming a third aperture in a side wall of the first portion of the body tissue conduit;

forming a fourth aperture in a side wall of the second portion of the body tissue conduit;

approximating the first and third apertures;

installing a first hollow annular connector through the approximated first and third apertures to form a first hollow annular anastomotic connection between the side walls of the graft conduit and the body tissue conduit annularly around the approximated first and third apertures;

approximating the second and fourth apertures; and

installing a second hollow annular connector through the approximated second and fourth apertures to form a second hollow annular anastomotic connection between the side walls of the graft conduit and the body tissue conduit annularly around the approximated second and fourth apertures.

2. The method defined in claim 1 wherein the installing a first hollow annular connector comprises:

inserting the first connector into the graft conduit via the first severed end;

moving the first connector along the interior of the

graft conduit from the first severed end to the first aperture; and

extending a first axial portion of the first connector from the first aperture.

3. The method defined in claim 2 wherein the installing the first hollow annular connector further comprises:

inserting the first axial portion of the first connector into the third aperture.

4. The method defined in claim 3 wherein the installing the first hollow annular connector further comprises:

shielding the first axial portion of the first connector at least during the inserting the first connector into the graft conduit, the moving, the extending, and the inserting the first axial portion into the third aperture; and thereafter unshielding the first axial portion of the first connector.

5. The method defined in claim 3 wherein the installing the first hollow annular connector further comprises:

deforming the first connector to cause it to press together the side wall of the graft conduit annularly around the first aperture and the side wall of the body tissue conduit annularly around the third aperture.

6. The method defined in claim 4 wherein the deforming comprises:

annularly enlarging the first connector.

7. The method defined in claim 6 wherein the first connector is disposed annularly around a selectively

inflatable first balloon during the inserting the first connector into the graft conduit, the moving, the extending, the inserting the first axial portion into the third aperture, the deforming, and the annularly enlarging, and wherein the annularly enlarging comprises:

inflating the first balloon.

8. The method defined in claim 7 further comprising:

after the inflating, deflating the first balloon and removing the first balloon from the patient via the first severed end.

9. The method defined in claim 8 further comprising:

after the removing, closing the graft conduit between the first severed end and the first aperture.

10. The method defined in claim 1 wherein the installing a second hollow annular connector comprises:

inserting the second connector into the graft conduit via the second severed end;

moving the second connector along the interior of the graft conduit from the second end to the second aperture;

extending a first axial portion of the second connector from the second aperture;

inserting the first axial portion of the second connector into the fourth aperture; and

deforming the second connector to cause it to press together the side wall of the graft conduit annularly around the second aperture and the side wall of the body tissue conduit annularly around the fourth aperture.

11. The method defined in claim 10 wherein the installing the second hollow annular connector further

comprises:

shielding the first axial portion of the second connector at least during the inserting the second connector into the graft conduit, the moving the second connector, the extending the first axial portion of the second connector, and the inserting the first axial portion of the second connector; and thereafter unshielding the first axial portion of the second connector.

12. The method defined in claim 10 wherein the deforming the second connector comprises:

annularly enlarging the second connector.

13. The method defined in claim 12 wherein the second connector is disposed annularly around a selectively inflatable second balloon during the inserting the second connector into the graft conduit, the moving the second connector, the extending the first axial portion of the second connector, and the inserting the first axial portion of the second connector, the deforming the second connector, and the annularly enlarging the second connector, and wherein the annularly enlarging the second connector comprises:

inflating the second balloon.

14. The method defined in claim 13 further comprising:

after the inflating the second balloon, deflating the second balloon and removing the second balloon from the patient via the second severed end.

15. The method defined in claim 14 further comprising:

after the removing the second balloon, closing the graft conduit between the second severed end and the second aperture.

Pending Claims

1. A method for making an anastomotic connection between a side wall of a first conduit and a side wall of a second conduit, comprising:

attaching the first conduit to the second conduit wherein an attached region is created; and

making an aperture in the attached region;

the first conduit and the second conduit forming a fluid-tight anastomotic connection therebetween.

2. The method as defined in claim 1, wherein the first conduit and the second conduit are relatively adjacent to each other.

3. The method as defined in claim 1, wherein attaching the first conduit to the second conduit comprises placing an adhesive between the first conduit and the second conduit.

4. The method as defined in claim 1, wherein attaching the first conduit to the second conduit comprises suturing the first conduit to the second conduit.

5. The method as defined in claim 1, wherein creating the aperture in the attached region comprises severing tissue using a cutting instrument.

6. The method as defined in claim 5, wherein the cutting instrument further comprises cutting the tissue with a rotatable coring tip.

7. The method as defined in claim 5, wherein the

cutting instrument further comprises retaining the severed tissue in the attached region using a tissue holding structure.

8. The method as defined in claim 7, wherein the tissue holding structure further comprises preventing the severed tissue from entering a patient's bloodstream using a retention structure.

9. The method as defined in claim 5, further comprising inserting the cutting instrument through an opening in a wall of the first conduit.

10. The method as defined in claim 5, further comprising inserting the cutting instrument through an end of the first conduit.

11. The method as defined in claim 1, further comprising:

after attaching the first and second conduits, closing an end portion of the first conduit.

12. A method for creating an anastomotic connection between tubular conduits in a patient, comprising:

attaching a side wall of a first conduit to a side wall of a second conduit;

creating an attached region using an adhesive; and

making an aperture in the attached region using a cutting instrument;

the first conduit and the second conduit forming a fluid-tight anastomotic connection therebetween.

13. The method as defined in claim 12, wherein the cutting instrument further comprises cutting the tissue with a rotatable coring tip.

14. The method as defined in claim 12, wherein the cutting instrument further comprises retaining the severed tissue in the attached region using a tissue holding structure.

15. The method as defined in claim 14, wherein the tissue holding structure further comprises preventing the severed tissue from entering a patient's bloodstream using a retention structure.

16. The method as defined in claim 12, further comprising inserting the cutting instrument through an opening in a wall of the first conduit.

17. The method as defined in claim 12, further comprising inserting the cutting instrument through an end of the first conduit.

18. The method as defined in claim 12, further comprising:

after attaching the first and second conduits, closing an end portion of the first conduit.

19. A method for creating an anastomotic connection between tubular conduits in a patient, comprising:

attaching a sidewall of a first conduit to a sidewall of a second conduit;

creating an attached area using a suturing technique; and

making an aperture between the first conduit and the second conduit within the attached area using a cutting instrument;

the first conduit and the second conduit forming a fluid-tight anastomotic connection therebetween.

22. The method as defined in claim 19, wherein the cutting instrument further comprises cutting the tissue with a rotatable coring tip.

23. The method as defined in claim 19, wherein the cutting instrument further comprises retaining the severed tissue using a tissue holding structure.

24. The method as defined in claim 23, wherein the tissue holding structure further comprises preventing the severed tissue from entering a patient's bloodstream using a retention structure.

25. The method as defined in claim 19, further comprising:

after attaching the first and second conduits, closing an end portion of the first conduit.

26. The method as defined in claim 9, further comprising:

after attaching the first and second conduits, closing the opening in the wall of the first conduit.

27. The method as defined in claim 16, further comprising:

after attaching the first and second conduits, closing the opening in the wall of the first conduit.

28. The method as defined in claim 21, further comprising inserting the cutting instrument through an opening in a wall of the first conduit.

29. The method as defined in claim 28, further comprising:

after attaching the first and second conduits, closing the opening in the wall of the first conduit.

Pending Claims

1. A connector for use in making an anastomotic connection between a first aperture in a side wall of a graft conduit and a second aperture in a side wall of a body tissue conduit in a patient comprising a unitary structure disposed annularly about a longitudinal axis and having axially spaced first and second portions, the first portion having a plurality of annularly spaced first fingers that expand radially out to secure a perimeter of the first aperture to an exterior surface of the side wall of the body tissue conduit along a perimeter of the second aperture and having a plurality of annularly spaced members that have free ends configured to engage the side wall of the graft conduit, and the second portion having a plurality of annularly spaced second fingers that expand radially out to engage the side wall of the body tissue conduit.

2. The connector defined in claim 1 wherein the free ends of the annularly spaced members point away from the second portion.

3. The connector defined in claim 1 wherein the free ends of the annularly spaced members point toward the second portion.

4. The connector defined in claim 1 wherein the free ends of the annularly spaced members are sharply pointed.

5. The connector defined in claim 1 wherein a member of the plurality of annularly spaced members is connected to a first finger of the plurality of first fingers

at the end of the first finger that is farthest from the second portion.

6. The connector defined in claim 1 wherein the structure has a medial portion between the axially spaced first and second portions.

7. The connector defined in claim 6 wherein at least one of the first portion, medial portion, and second portion is annularly enlargeable.

8. The connector defined in claim 7 wherein the annular enlargement of the at least one of the first portion, medial portion, and second portion is an elastic enlargement.

9. The connector defined in claim 6 wherein the medial portion has a fixed diameter.

10. The connector defined in claim 6 wherein the medial portion has a plurality of annularly spaced members that point toward the first portion to assist in positioning the connector with respect to the first aperture.

11. The connector defined in claim 1 wherein the second portion has a plurality of annularly spaced members that point toward the first portion to assist in positioning the connector with respect to the first aperture.

12. The connector defined in claim 1 wherein the radially outward expansion of the plurality of first fingers and the plurality of second fingers is an elastic expansion.

13. The connector defined in claim 1 wherein at least one of the plurality of second fingers has an attachment portion at the end of the at least one of the plurality of

second fingers that is farthest from the first portion for attachment to a mold.

14. Apparatus for making an anastomotic connection between a first aperture in a side wall of a graft conduit and a second aperture in a side wall of a body tissue conduit in a patient comprising:

a tip structure having a substantially hemispherical distal end portion wherein the tip structure is configured for passage through the second aperture from outside the body tissue conduit;

a first tubular structure connected to the tip structure that extends proximally from the tip structure;

a substantially conical structure wherein the conical structure is disposed annularly around the first tubular structure;

a second tubular structure connected to the conical structure that extends proximally from the conical structure, and wherein the second tubular structure is disposed annularly around the first tubular structure; and

a third tubular structure wherein the third tubular structure is disposed annularly around the first and second tubular structures.

15. The apparatus defined in claim 14 wherein a diameter of the third tubular structure increases abruptly at a distal end portion of the third tubular structure.

16. The apparatus defined in claim 14 further comprising:

a hollow annular connector having a first portion and a second portion; and

wherein the tip structure is configured to shield at least a portion of the second portion of the connector.

17. The apparatus defined in claim 16 wherein the at least a portion of the second portion is constrained between the tip structure and the conical structure.

18. The apparatus defined in claim 14 further comprising:

a hollow annular connector having a first portion and a second portion; and

wherein the third tubular structure is configured to shield at least a portion of the first portion.

19. Apparatus for forming an aperture in a side wall of a graft conduit using a blade comprising:

a dilator structure having a substantially conical tip portion configured for passage through an open end of the graft conduit and a shaft portion extending proximally from the tip portion;

a tubular shaft structure extending from the proximal end of the dilator structure;

a tubular sheath disposed annularly around at least a portion of the dilator; and

a spring disposed annularly around the tubular shaft structure configured to control the movement of the dilator structure within the tubular sheath structure.

20. A method for making an anastomotic connection between a first aperture in a side wall of a graft conduit and a second aperture in a side wall of a body tissue conduit in a patient comprising:

introducing a hollow annular connector into the graft conduit so that at least a first axial portion of the connector is inside the graft conduit and a second axial portion of the connector extends from the graft conduit via the first aperture, and wherein at least a portion of the first axial portion is shielded during the introduction;

unshielding the at least a portion of the first axial portion;

approximating the first and second apertures so that the second axial portion of the connector extends from the first aperture into the second aperture, and wherein at least a portion of the second axial portion is shielded during the approximation; and

unshielding the at least a portion of the second axial portion so that the connector secures a perimeter of the first aperture to an exterior surface of the side wall of the body tissue conduit along a perimeter of the second aperture.

21. The method defined in claim 20 wherein the graft conduit has first and second segments that extend in respective opposite directions along the graft conduit from the first aperture, wherein body fluid will flow in the first segment after the connection has been made, wherein the second segment has a third aperture spaced from the first aperture, and wherein the introducing comprises:

inserting the connector into the second segment via the third aperture and passing the connector along the inside of the second segment to the first aperture.

22. The method defined in claim 21 further comprising closing the second segment after the connection has been made.

23. The method defined in claim 20 wherein the introducing comprises:

inserting the connector into the graft conduit via the first aperture.

24. The method defined in claim 20 wherein the first axial portion of the connector has a plurality of first fingers configured to engage the side wall of the graft

conduit, and wherein the unshielding the at least a portion of the first portion comprises:

engaging the side wall of the graft conduit with the plurality of fingers.

25. The method defined in claim 20 wherein the first axial portion of the connector has a plurality of members having free ends configured to engage the side wall of the graft conduit, and wherein the unshielding the at least a portion of the first portion comprises:

engaging the side wall of the graft conduit with the free ends of the plurality of members.

26. The method defined in claim 20 wherein the second axial portion of the connector has a plurality of fingers configured to engage the side wall of the body tissue conduit, and wherein the unshielding the at least a portion of the second portion comprises:

engaging the side wall of the body tissue conduit with the plurality of fingers.

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Pending Claims

1. A method of producing a hollow annular anastomotic connection between a first aperture in a side wall of a graft conduit and a second aperture in a side wall of a body tissue conduit in a patient using a hollow annular connector having a first axial portion, a second axial portion, and a medial portion therebetween, wherein the first axial portion has a plurality of first members and the second axial portion has a plurality of second members, wherein the diameters defined by both the first members and second members are larger than the diameter of the medial portion, and wherein an axial spacing is defined between the first members and the second members, comprising:

introducing the hollow annular connector into the graft conduit so that the first axial portion of the connector is disposed inside the graft conduit and the second axial portion of the connector extends out of the graft conduit via the first aperture;

approximating the first and second apertures so that the second axial portion of the connector extends into the body tissue conduit via the second aperture; and

deforming the connector so that the axial spacing decreases and so that the first and second members press together the side walls of the body tissue conduit and the graft conduit annularly around the first and second apertures.

2. The method defined in claim 1 wherein the graft conduit has first and second segments that extend in respective opposite directions along the graft conduit from the first aperture, wherein body fluid will flow in the first segment after the connection has been made, wherein the second

segment has a third aperture spaced from the first aperture, and wherein the introducing comprises:

inserting the connector into the second segment via the third aperture and passing the connector along the inside of the second segment to the first aperture.

3. The method defined in claim 2 further comprising:

before the inserting, providing an introduction structure having a tapered portion configured to shield the second axial portion of the connector, and

wherein the inserting the connector comprises inserting the tapered portion of the introduction structure into the second segment via the third aperture while shielding the second axial portion of the connector.

4. The method defined in claim 2 further comprising:

before the inserting, providing a selectively inflatable balloon that is disposed annularly within the connector, and

wherein the inserting the connector comprises inserting the balloon that is disposed annularly within the connector into the second segment via the third aperture.

5. The method defined in claim 2 further comprising closing the second segment after the connection has been made.

6. The method defined in claim 1 further comprising:

shielding the second axial portion of the connector during at least part of the introducing.

7. The method defined in claim 6 further comprising:

unshielding the second axial portion of the connector after the approximating and before the deforming.

8. The method defined in claim 1 wherein the deforming comprises:

annularly enlarging the connector.

9. The method defined in claim 1 wherein the deforming comprises:

axially shortening the connector.

10. The method defined in claim 1 wherein the connector is disposed annularly around a selectively inflatable balloon, and wherein the deforming comprises:

inflating the balloon.

11. The method defined in claim 10 further comprising:

after the deforming, deflating the balloon.

12. The method defined in claim 11 further comprising:

after the deflating, removing the balloon from inside the connector and from the patient.

13. The method defined in claim 1 wherein the plurality of first members have free end portions configured to engage the side wall of the graft conduit, and wherein the plurality of second members have free end portions configured to engage the body tissue conduit, and wherein the deforming comprises:

engaging the side wall of the graft conduit with the free end portions of the first members and engaging the side

wall of the body tissue conduit with the free end portions of the second members.

14. Apparatus for inserting a hollow annular connector, around which a first aperture in a side wall of a graft conduit is disposed, into a second aperture in a side wall of a patient's body tissue conduit from outside the body tissue conduit comprising:

a tapered portion configured to shield a portion of the connector during insertion wherein the tapered portion is constructed of a flexible material; and

a shaft portion extending from the tapered portion wherein the shaft portion is constructed of the flexible material.

15. The apparatus defined in claim 14 wherein the tapered portion defines an annular recess for shielding the portion of the connector during insertion.

16. The apparatus defined in claim 15 wherein the shaft portion extends from the annular recess.

17. The apparatus defined in claim 14 further comprising:

a tubular structure having a lumen that is in fluid communication with an internal cavity of the tapered portion and a lumen of the shaft portion.

18. The apparatus defined in claim 17 wherein a portion of the shaft portion having an open end is disposed annularly within the tubular structure, and wherein the open end is attached to the tubular structure.

19. Apparatus for producing a hollow annular anastomotic connection between a first aperture in a side wall

of a graft conduit and a second aperture in a side wall of a body tissue conduit in a patient comprising:

a hollow annular connector having a first axial portion configured to engage the graft conduit and a second axial portion configured to engage the body tissue conduit, the connector being deformable from a first configuration to a second configuration having an enlarged annular dimension;

a balloon structure having a selectively inflatable balloon configured for positioning within the connector to deform the connector from the first configuration to the second configuration;

an introduction structure having a first configuration and a second configuration, the first configuration having a tapered portion defining an annular recess for shielding the second axial portion of the connector, and the second configuration having a smaller dimension, wherein the introduction structure moves to the second configuration to unshield the second axial portion of the connector; and

a rigid tubular structure disposed annularly around the balloon adjacent the first axial portion of the connector configured to restrict the inflation of the balloon.

20. Apparatus for producing a hollow annular anastomotic connection between a first aperture in a side wall of a graft conduit and a second aperture in a side wall of a body tissue conduit in a patient comprising:

an introduction structure wherein the introduction structure has a tapered portion and a shaft portion extending from the tapered portion, and wherein the tapered portion has a diameter that is greater than the diameter of the first aperture; and

a hollow annular connector wherein the connector has a plurality of first members configured to engage the graft conduit and a plurality of second members that are shielded by

the tapered portion during insertion and that are configured to engage the body tissue conduit, and wherein the first members have a diameter that is greater than the diameter of the tapered portion.

21. An apparatus for anchoring a graft conduit to a tissue surface in a patient, after an anastomotic connection has been made between the graft conduit and a body tissue conduit in the patient, comprising a channel that is configured to receive the graft conduit within the confines of the channel, and wherein the channel has anchoring structures to engage the tissue surface.

22. The apparatus defined in claim 21 wherein the anchoring structures are barbs.

23. The apparatus defined in claim 21 wherein the anchoring structures are adhesive pads.

24. The apparatus defined in claim 21 wherein the channel is curved so that the channel takes up excess length of the graft conduit.

25. The apparatus defined in claim 21 wherein the channel is straight.

26. The apparatus defined in claim 25 wherein the channel is positioned adjacent to the anastomotic connection to reduce the tension on the graft conduit at the anastomotic connection.

27. The apparatus defined in claim 21 wherein an inner surface of the channel is rough so that the inner surface engages the graft conduit.

28. The apparatus defined in claim 21 wherein an inner surface of the channel is coated with an adhesive so that the inner surface engages the graft conduit.

29. The apparatus defined in claim 21 wherein the channel is U-shaped.